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EDEXCEL INTERNATIONAL GCSE MATHS: QUESTIONS BY TOPIC

Perimeter, Area & Volume (G4)

International GCSE Mathematics A (4MA1) · Higher tier

106 questions · 463 marks · Mark schemes included

Past papers June 2018 - June 2025 · 3 sub-topics

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HOW TO USE THIS BOOKLET

Questions are grouped by sub-topic and run from the lowest to the highest mark tariff, then oldest paper first.
Click any row below to jump straight to that sub-topic or question.
On every question page, click ANSWER in the top-right corner to jump to its mark scheme; < QUESTION brings you back.
A gold bar in the left margin marks exactly where the question sits on the original page.
Diagrams, graphs, grids and tables are printed exactly as they appear in the original papers.
Each question is filed under its main topic; longer questions may also test skills from other topics.

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QUESTIONS

106 questions · 463 marks · 3 sub-topics

SUB-TOPIC G4a

PERIMETER & AREA OF 2D SHAPES

Sub-topic G4a · 22 questions · 103 marks · lowest tariff first

Answer ALL TWENTY THREE questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 Here is a hexagon *ABCDEF*.

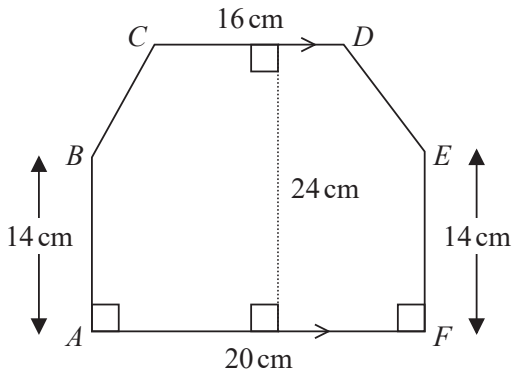


Diagram **NOT** accurately drawn

CD is parallel to *AF*.

Work out the area of hexagon *ABCDEF*.

..... cm^2

(Total for Question 1 is 4 marks)

3 The diagram shows a shape.

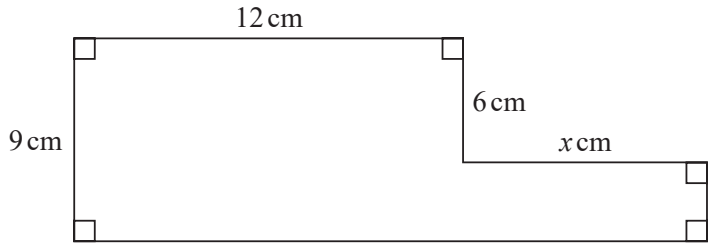


Diagram **NOT** accurately drawn

The shape has area 129 cm^2

Work out the value of x.

x = ...

(Total for Question 3 is 4 marks)

20

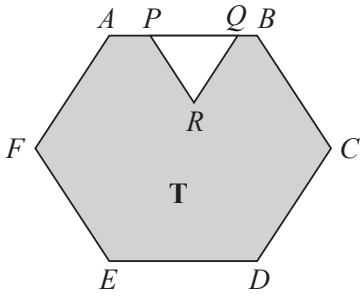


Diagram **NOT** accurately drawn

The diagram shows a shaded region **T** formed by removing an equilateral triangle PQR from a regular hexagon $ABCDEF$.

The points P and Q lie on AB such that $AB = 1.5 \times PQ$

Given that the area of region **T** is $72\sqrt{3}$ cm^2

work out the length of PQ.

..... cm

(Total for Question 20 is 4 marks)

3

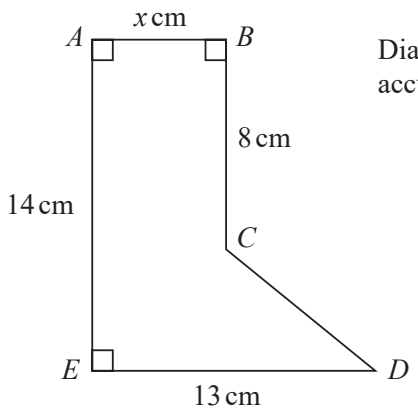


Diagram **NOT** accurately drawn

The diagram shows the shape *ABCDE*.

The area of the shape is 91.8 cm²

Work out the value of *x*.

x = ...

(Total for Question 3 is 4 marks)

2 Here are two rectangles, rectangle *A* and rectangle *B*.

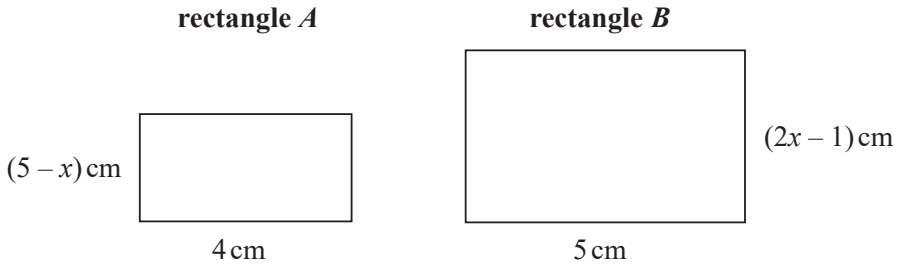


Diagram **NOT** accurately drawn

The area of rectangle *B* is twice the area of rectangle *A*.

Work out the value of *x*.
Show your working clearly.

x = ...

(Total for Question 2 is 4 marks)

5 The diagram shows an 8-sided shape *ABCDEFGH*.

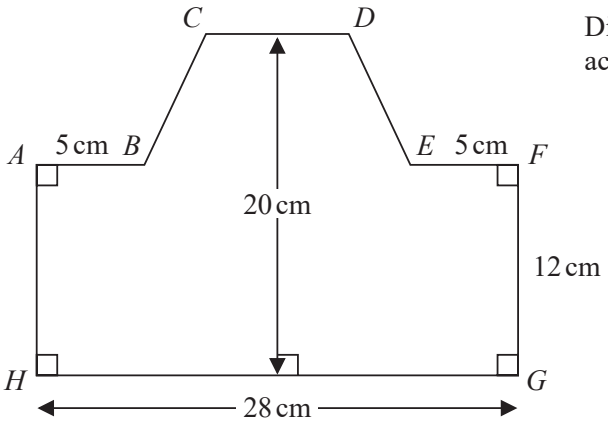


Diagram **NOT** accurately drawn

HG = 28 cm *FG* = 12 cm *AB* = *EF* = 5 cm
The height of the shape is 20 cm
CD is parallel to *HG*

The area of shape *ABCDEFGH* is 434 cm^2

Find the length of *CD*.

..... cm

(Total for Question 5 is 4 marks)

9 The diagram shows an isosceles triangle ABC

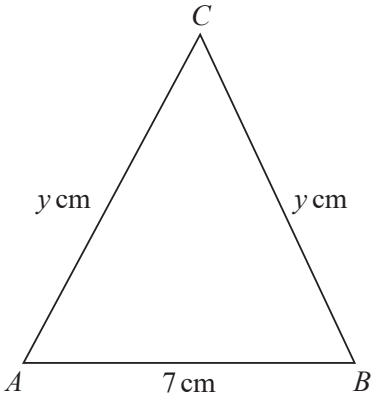


Diagram **NOT** accurately drawn

$AB = 7\,\text{cm}$ $AC = BC = y\,\text{cm}$

The area of the triangle is $42\,\text{cm}^2$

Work out the value of y

$y =$ .....

(Total for Question 9 is 4 marks)

4 The diagram shows rectangle $ABCD$

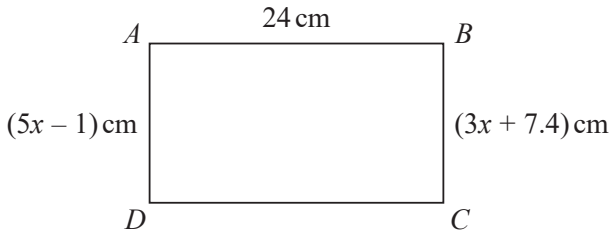


Diagram **NOT** accurately drawn

Work out the perimeter of the rectangle.
Show your working clearly.

..... cm

(Total for Question 4 is 4 marks)

5 A field is in the shape of a trapezium.

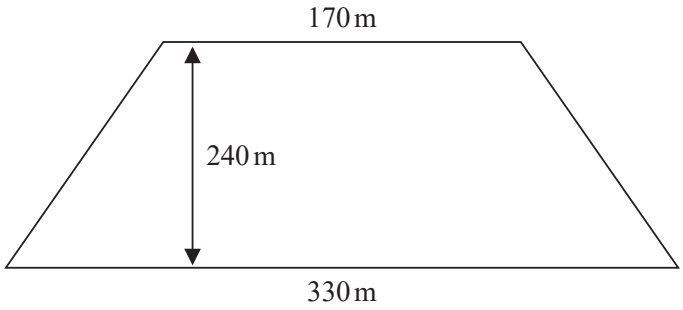


Diagram **NOT** accurately drawn

The field is sold for a price of $49 650

Given that 1 hectare = 10 000 m^2

work out the average price of the field per hectare.

$.....

(Total for Question 5 is 4 marks)

7 The diagram shows a 6-sided shape $ABCDEF$

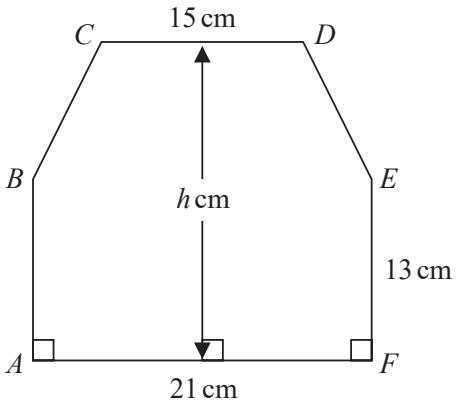


Diagram **NOT** accurately drawn

$AF = 21$ cm $CD = 15$ cm $AB = FE = 13$ cm

The perpendicular height of the shape is h cm
CD is parallel to AF

The area of the shape is 390 cm^2

Work out the value of h

$h =$ .....

(Total for Question 7 is 4 marks)

5 Calvin has 12 identical rectangular tiles.
He arranges the tiles to fit exactly round the edge of a shaded rectangle, as shown in the diagram below.

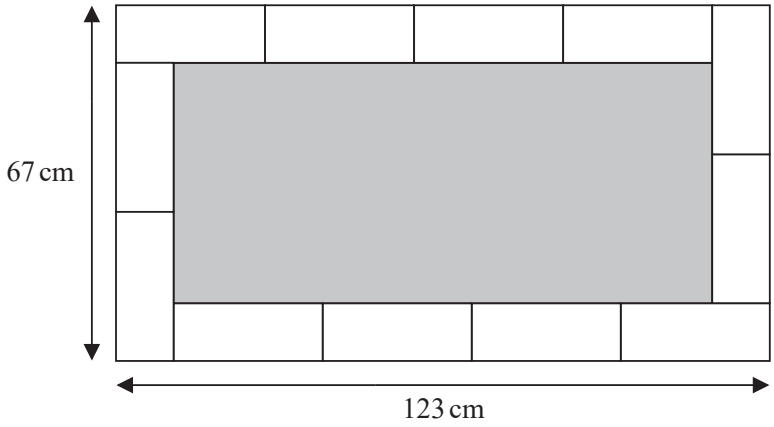


Diagram **NOT** accurately drawn

Work out the area of the shaded rectangle.

cm^2

(Total for Question 5 is 5 marks)

10 The diagram shows a regular hexagon, *ABCDEF*, and an isosceles triangle, *GHJ*.

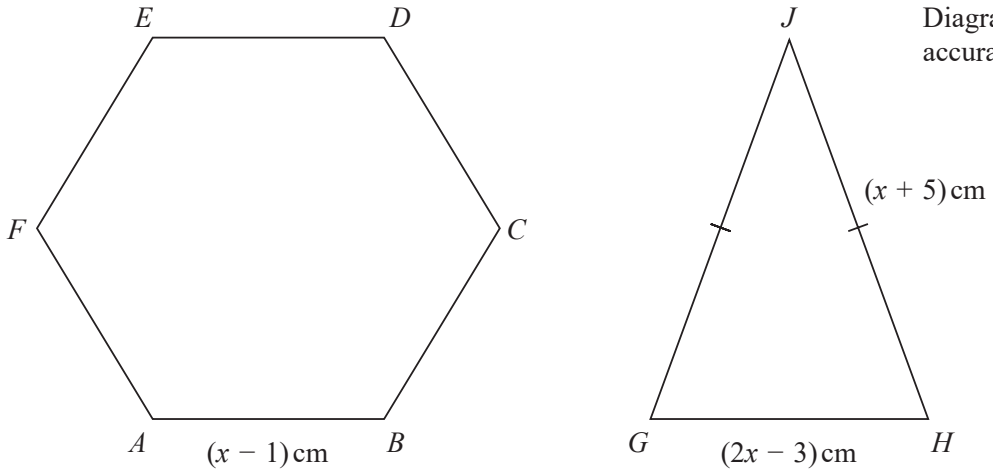


Diagram **NOT** accurately drawn

The perimeter of the hexagon is equal to the perimeter of the triangle.

Find the length of each side of the hexagon.
Show clear algebraic working.

..... cm

(Total for Question 10 is 5 marks)

10 The diagram shows one face of a wall.
This face is in the shape of a pentagon with exactly one line of symmetry.

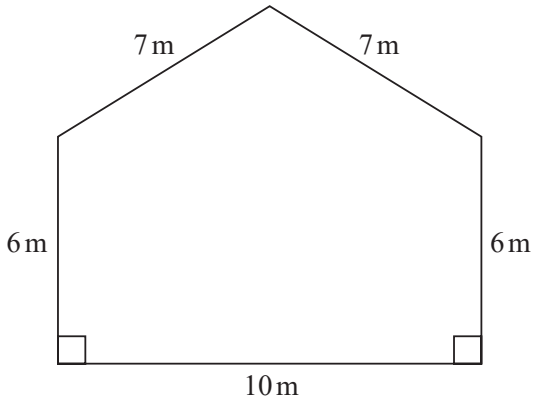


Diagram **NOT** accurately drawn

Omondi is going to paint this face of the wall once.
He has to buy all the paint that he needs to use.

The paint in each tin of paint Omondi is going to buy will cover 16 m^2 of the face of the wall.

Work out the least number of tins of paint Omondi will need to buy.
Show your working clearly.

.....

(Total for Question 10 is 5 marks)

4 The diagram shows the front of a wooden door with a semicircular glass window.

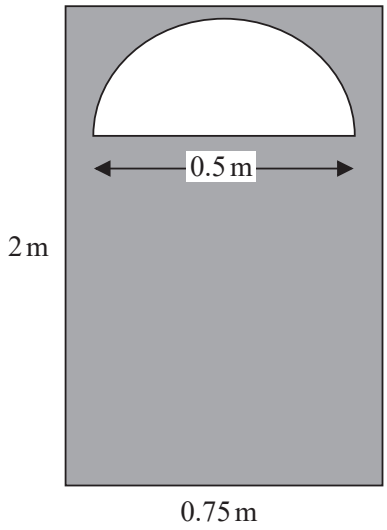


Diagram **NOT** accurately drawn

Julie wants to apply 2 coats of wood varnish to the front of the door, shown shaded in the diagram.

250 millilitres of wood varnish covers 4 m^2 of the wood.

Work out how many millilitres of wood varnish Julie will need.
Give your answer correct to the nearest millilitre.

..... millilitres

(Total for Question 4 is 5 marks)

10 The diagram shows a hexagon $ABCDEF$

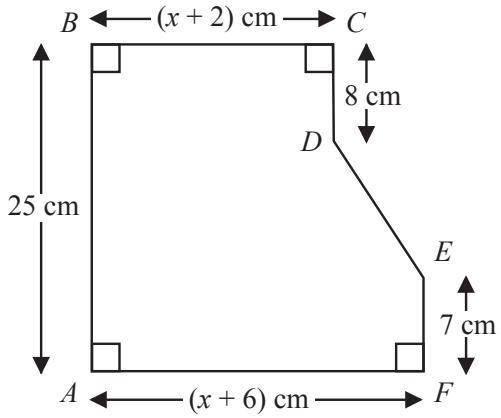


Diagram **NOT** accurately drawn

$AB = 25$ cm $BC = (x + 2)$ cm $CD = 8$ cm $EF = 7$ cm $AF = (x + 6)$ cm

The area of hexagon $ABCDEF$ is 258 cm²

Work out the value of x

$x =$ .....

(Total for Question 10 is 5 marks)

10 The diagram shows a hexagon *ABCDEF*

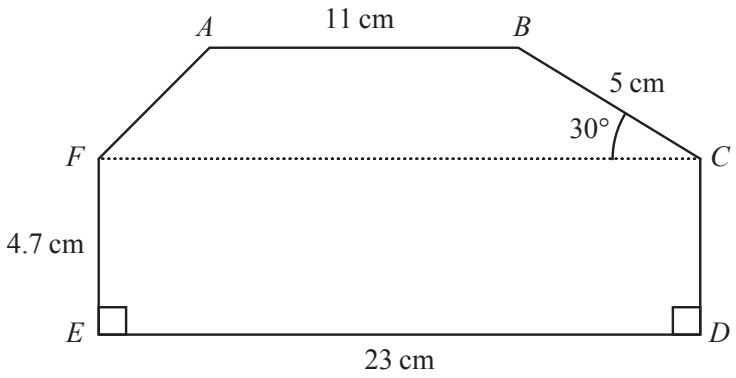


Diagram **NOT** accurately drawn

Angle *BCF* = 30°
AB, *FC* and *ED* are parallel.

Calculate the area of *ABCDEF*
Show your working clearly.

..... cm^2

(Total for Question 10 is 5 marks)

25 The diagram shows an equilateral triangle ABC and a circle with centre O

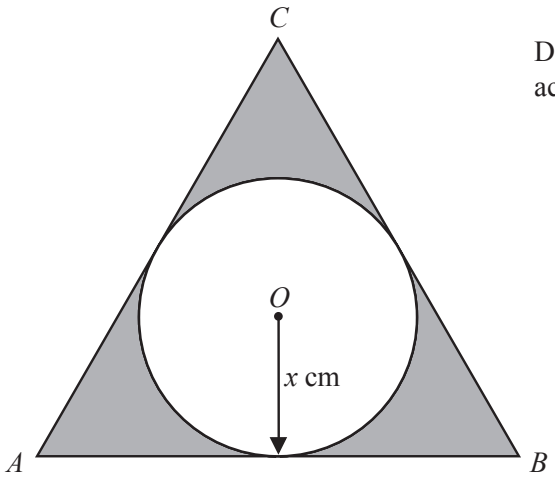


Diagram **NOT** accurately drawn

AB, BC and CA are tangents to the circle.

The radius of the circle is x cm

The total area, in cm^2, of the regions shown shaded in the diagram is nx^2

Find the value of n
Give your answer correct to 3 significant figures.

$n =$ .....

(Total for Question 25 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS

9

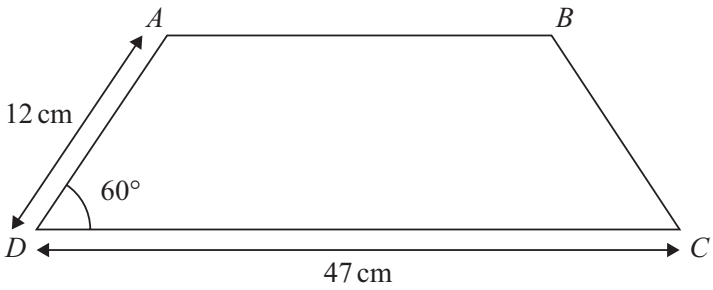


Diagram **NOT** accurately drawn

ABCD is a trapezium with one line of symmetry.

angle *ADC* = 60° *AD* = 12 cm *DC* = 47 cm

Work out the area of the trapezium.
Give your answer correct to 3 significant figures.
Show your working clearly.

..... cm^2

(Total for Question 9 is 5 marks)

4 Joshua is going to cover a floor with tiles for a customer.
The area of the floor is 45 m^2

Joshua buys one box of tiles for each 1.5 m^2 of floor area.
Each box of tiles costs £64

Joshua also buys 5 bags of tile adhesive.
Each bag of tile adhesive costs £12

Joshua charges the customer £3000

Work out his percentage profit.
Give your answer correct to one decimal place.

..... %

(Total for Question 4 is 5 marks)

15 The diagram shows a trapezium.

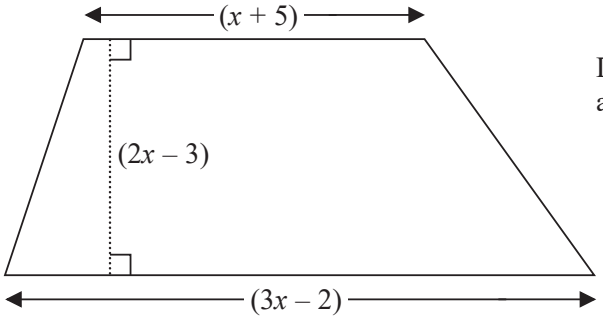


Diagram **NOT** accurately drawn

All measurements shown on the diagram are in centimetres.

The area of the trapezium is 133 cm^2

(a) Show that $8x^2 - 6x - 275 = 0$

(3)

(b) Find the value of x.
Show your working clearly.

$x =$

(3)

(Total for Question 15 is 6 marks)

22 The diagram shows a regular octagon *ABCDEFGH*.

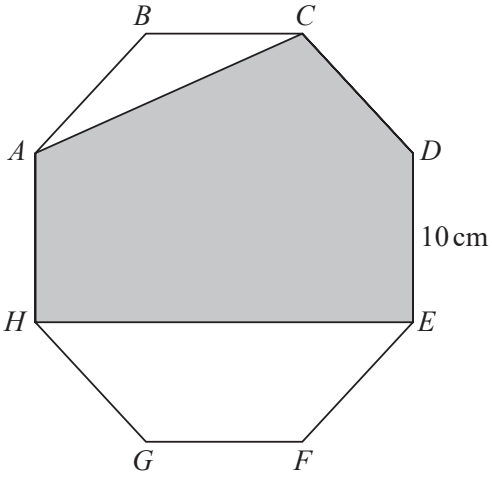


Diagram **NOT** accurately drawn

Each side of the octagon has length 10 cm.

Find the area of the shaded region *ACDEH*.
Give your answer correct to the nearest cm^2

..... cm^2

(Total for Question 22 is 6 marks)

Turn over for Question 23

19 *ABCED* is a five-sided shape.

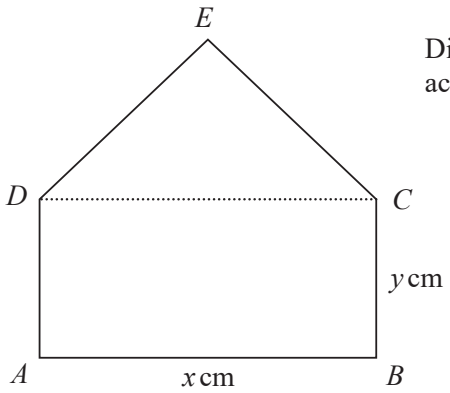


Diagram **NOT** accurately drawn

ABCD is a rectangle.
CED is an equilateral triangle.

$AB = x$ cm $\quad BC = y$ cm

The perimeter of *ABCED* is 100 cm.
The area of *ABCED* is R cm^2

(a) Show that $R = \frac{x}{4}\left(200 - \left[6 - \sqrt{3}\right]x\right)$

(3)

(b) (i) Find the value of x for which R has its maximum value.

Give your answer in the form $\frac{p}{q - \sqrt{3}}$ where p and q are integers.

$x =$ .....

(2)

(ii) Explain why the maximum value of R is given by this value of x.

.....

.....

.....

(1)

(Total for Question 19 is 6 marks)

Turn over for Question 20

SUB-TOPIC G4b

CIRCLES, ARCS & SECTORS

Sub-topic G4b · 36 questions · 151 marks · lowest tariff first

12 The diagram shows a sector of a circle with radius 7 cm.

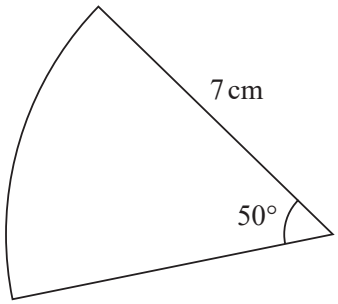


Diagram **NOT** accurately drawn

Work out the length of the arc of the sector.
Give your answer correct to one decimal place.

..... cm

(Total for Question 12 is 2 marks)

11 The diagram shows sector OPQ of a circle, centre O

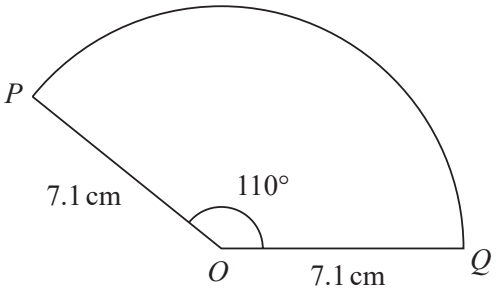


Diagram **NOT** accurately drawn

$OP = OQ = 7.1$ cm
Angle $POQ = 110°$

Calculate the area of sector OPQ
Give your answer correct to one decimal place.

..... cm^2

(Total for Question 11 is 2 marks)

11 $OABC$ is a sector of a circle, centre O

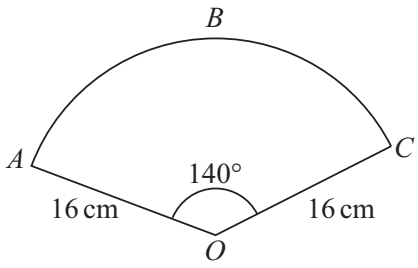


Diagram **NOT** accurately drawn

angle $AOC = 140°$
$OA = OC = 16$ cm

Calculate the area of the sector.
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 11 is 2 marks)

12 Express $\frac{5}{4} + \frac{x-3}{6x}$ as a single fraction in its simplest form.

.....

(Total for Question 12 is 3 marks)

10 The shape, shown shaded in the diagram, is the region between two semicircles.

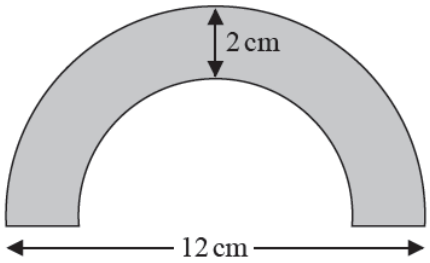


Diagram **NOT** accurately drawn

The diameter of the outer semicircle is 12 cm.
The shape has constant thickness 2 cm.

Calculate the area of the shape.
Give your answer as a multiple of π.

cm^2

(Total for Question 10 is 3 marks)

5 The diagram shows Yuen's garden.

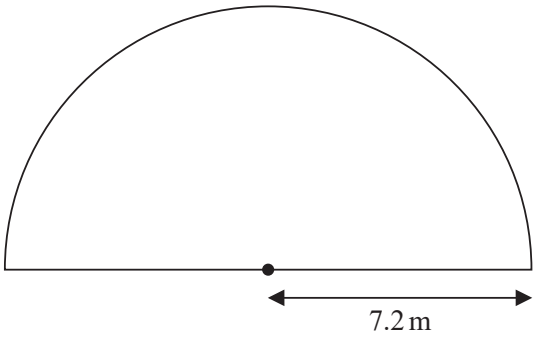


Diagram **NOT** accurately drawn

The garden is in the shape of a semicircle of radius 7.2 m.
Yuen is going to cover his garden with grass seed.

Yuen has 12 boxes of grass seed.
Each box of grass seed contains enough seed to cover 6 m^2 of the garden.

Has Yuen enough grass seed for his garden?
Show your working clearly.

(Total for Question 5 is 3 marks)

8 The region, shown shaded in the diagram, is a path.

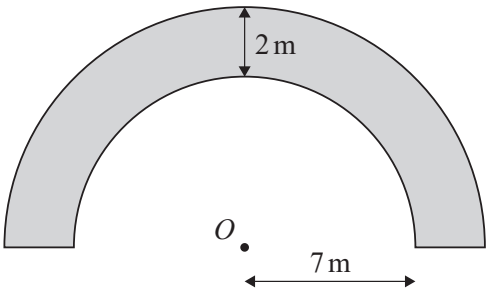


Diagram **NOT** accurately drawn

The boundary of the path is formed by two semicircles, with the same centre O, and two straight lines.

The inner semicircle has a radius of 7 metres.
The path has a width of 2 metres.

Work out the perimeter of the path.
Give your answer correct to one decimal place.

..... m

(Total for Question 8 is 3 marks)

2 The diagram shows a rectangle $ABCD$ and a semicircle with diameter AB where $AB = 12\,\text{cm}$. The point E lies on DC and also on the semicircle.

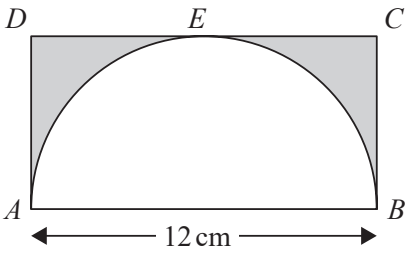


Diagram **NOT** accurately drawn

Work out the area of the shaded region.
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 2 is 3 marks)

13 The diagram shows a sector AOB of a circle with centre O

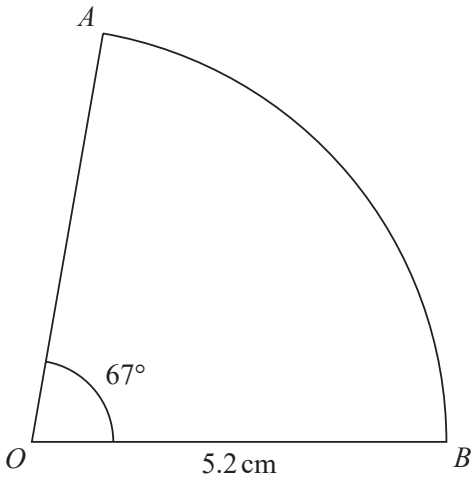


Diagram **NOT** accurately drawn

Angle $AOB = 67°$
$OA = OB = 5.2$ cm

Calculate the perimeter of the sector.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 13 is 3 marks)

14 A, B and C are points on a circle, centre O

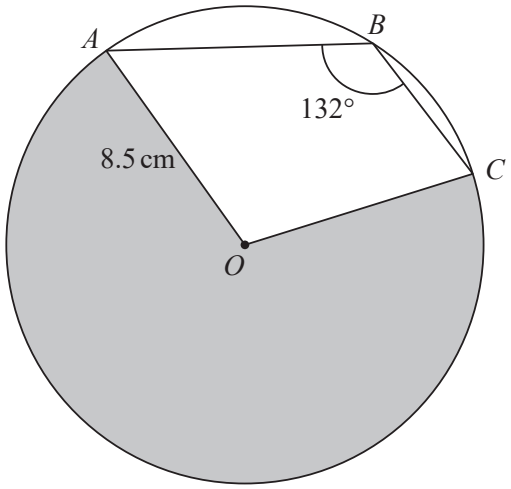


Diagram **NOT** accurately drawn

The radius of the circle is 8.5 cm
Angle $ABC = 132°$

Work out the perimeter of the shaded sector AOC
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 14 is 3 marks)

5 The diagram shows a shaded shape made from three identical semicircles, ***X***, ***Y*** and ***Z***

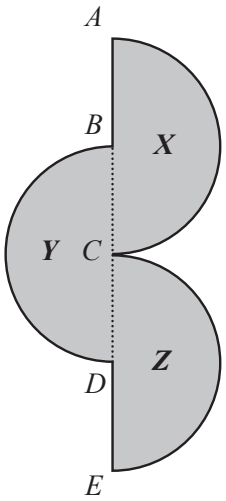


Diagram **NOT** accurately drawn

ABCDE is a straight line.

AC is the diameter of semicircle ***X*** and *B* is the centre of semicircle ***X***
BD is the diameter of semicircle ***Y*** and *C* is the centre of semicircle ***Y***
CE is the diameter of semicircle ***Z*** and *D* is the centre of semicircle ***Z***

$AC = BD = CE = 20$ cm

Work out the perimeter of the shaded shape.
Give your answer correct to the nearest whole number.

..... cm

(Total for Question 5 is 3 marks)

13 OAB is a sector of a circle with centre O and radius r cm.

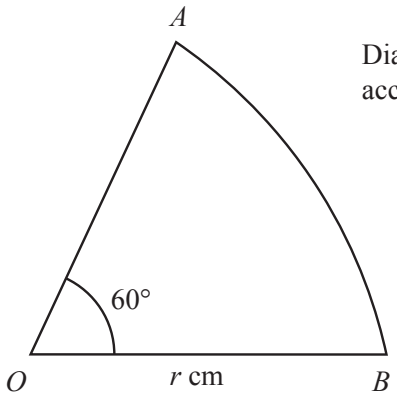


Diagram **NOT** accurately drawn

Angle $AOB = 60°$
The perimeter of the sector is P cm.

Find a formula for P in terms of r
Give your answer in the form $P = r(c\pi + k)$ where c and k are values to be found.

.....

(Total for Question 13 is 3 marks)

6

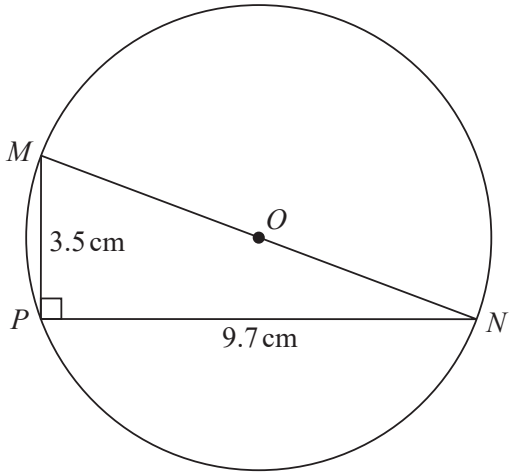


Diagram **NOT** accurately drawn

M, *N* and *P* are points on a circle, centre *O*.
MON is a diameter of the circle.

MP = 3.5 cm
PN = 9.7 cm

Angle *MPN* = 90°

Work out the circumference of the circle.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 6 is 4 marks)

19

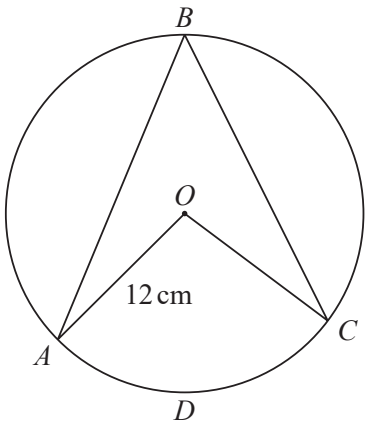


Diagram **NOT** accurately drawn

A, *B*, *C* and *D* are points on a circle with centre *O* and radius 12 cm.

The area of the sector *OADC* of the circle is 100 cm^2

Work out the size of angle *ABC*.
Give your answer correct to 3 significant figures.

.....°

(Total for Question 19 is 4 marks)

11 A circle centre O has radius 9 cm.

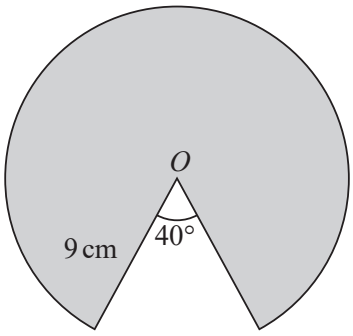


Diagram **NOT** accurately drawn

Calculate the perimeter of the shaded sector of the circle.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 11 is 4 marks)

12 Solve the simultaneous equations $2x + 7y = 17$
$5x + 3y = -1$

Show clear algebraic working.

$x =$ .....

$y =$ .....

(Total for Question 12 is 4 marks)

16 The diagram shows a circle with centre O

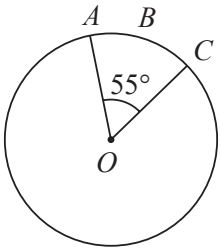


Diagram **NOT** accurately drawn

A, B and C are points on the circle so that the length of the arc ABC is 5 cm.

Given that angle $AOC = 55°$

work out the area of the circle.
Give your answer correct to one decimal place.

..... cm^2

(Total for Question 16 is 4 marks)

20 The diagram shows four identical circles drawn inside a square.

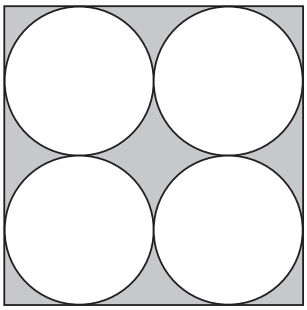


Diagram **NOT** accurately drawn

Each circle touches two other circles and two sides of the square.

The region inside the square that is outside the circles, shown shaded in the diagram, has a total area of 40 cm^2

Work out the perimeter of the square.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 20 is 4 marks)

5 The diagram shows a shape made from a square $ABCD$ and 4 identical semicircles.

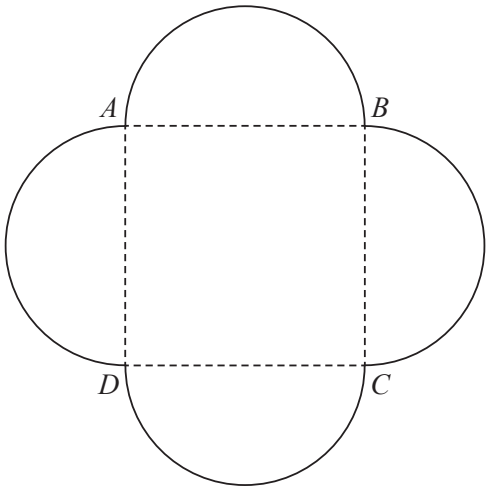


Diagram **NOT** accurately drawn

As shown in the diagram, the semicircles have AB, BC, CD and DA as diameters.

The area of the square is $36\,\text{cm}^2$

Calculate the total area of the shape.
Give your answer correct to one decimal place.

..... cm^2

(Total for Question 5 is 4 marks)

20 The diagram shows equilateral triangle ABC with sides of length 10 cm.
A circle is drawn inside the triangle.

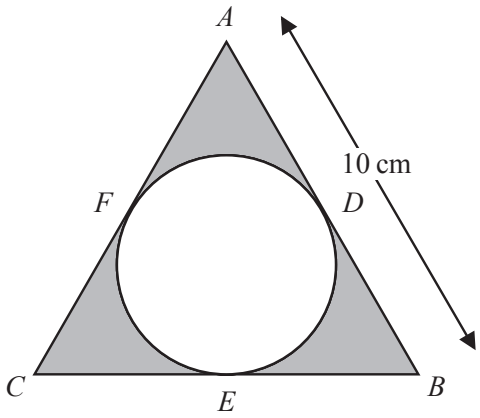


Diagram **NOT** accurately drawn

D, E and F are points on the circle.

ADB, BEC and CFA are tangents to the circle.

Calculate the total area of the regions shown shaded in the diagram.
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 20 is 4 marks)

20 The diagram shows a sector $OABC$ of a circle centre O

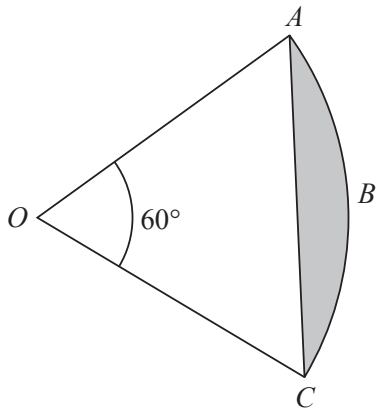


Diagram **NOT** accurately drawn

Angle $AOC = 60°$

The area of the shaded segment ABC is $38\,cm^2$

Work out the perimeter of the shaded segment ABC
Give your answer correct to one decimal place.

..... cm

(Total for Question 20 is 4 marks)

5 The diagram shows the design for a badge, which will be made using wire.
The design is a circle inside a square *ABCD*

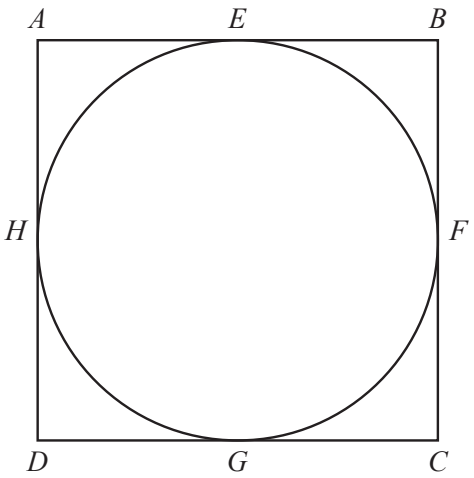


Diagram **NOT** accurately drawn

The circle touches the square at the points *E*, *F*, *G* and *H*

The area of the square is 81 cm^2

Calculate the total length of wire that will be needed to make the square and the circle.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 5 is 4 marks)

16 $OAPB$ is a sector of a circle, centre O

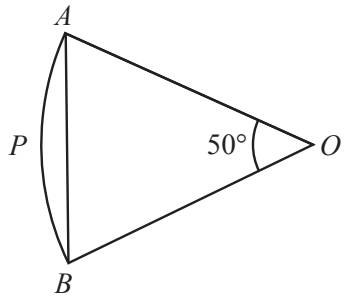


Diagram **NOT** accurately drawn

Angle $AOB = 50°$

Area of triangle $OAB = 120\ \text{cm}^2$

Work out the area of the sector $OAPB$
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 16 is 4 marks)

9 The diagram shows a shape made from a right-angled triangle and a semicircle.

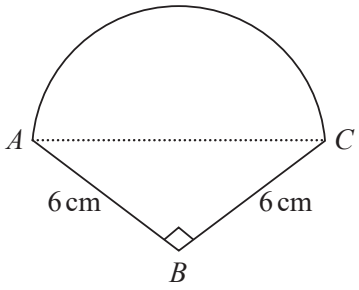


Diagram **NOT** accurately drawn

AC is the diameter of the semicircle.
$BA = BC = 6$ cm
Angle $ABC = 90°$

Work out the area of the shape.
Give your answer correct to 1 decimal place.

..... cm^2

(Total for Question 9 is 5 marks)

11 The diagram shows a shaded shape *ABCD* made from a semicircle *ABC* and a right-angled triangle *ACD*.

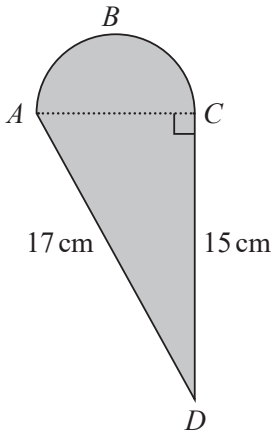


Diagram **NOT** accurately drawn

AC is the diameter of the semicircle *ABC*.

Work out the perimeter of the shaded shape.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 11 is 5 marks)

8 A, B and C are points on a circle with centre O.

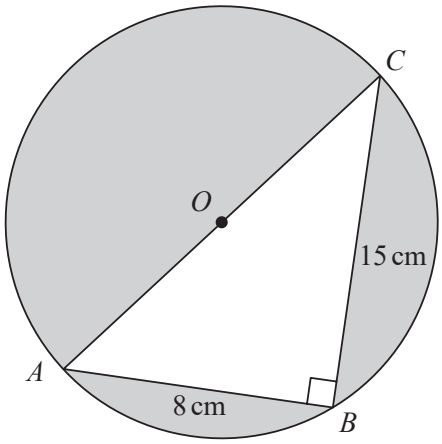


Diagram **NOT** accurately drawn

AOC is a diameter of the circle.

$AB = 8\,\text{cm}$ $BC = 15\,\text{cm}$

Angle $ABC = 90°$

Work out the total area of the regions shown shaded in the diagram.
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 8 is 5 marks)

9 $A = 2^3 \times 3^2 \times 5^2 \times 11$
$B = 2^4 \times 3 \times 5^4 \times 13$

Find the lowest common multiple (LCM) of A and B.
Give your answer as a product of powers of prime numbers.

.....

(Total for Question 9 is 2 marks)

20 A, B and C are points on a circle with centre O.

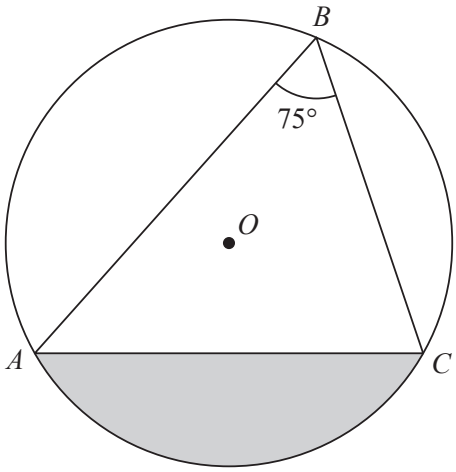


Diagram **NOT** accurately drawn

Angle $ABC = 75°$

The area of the shaded segment is $200\,cm^2$

Calculate the radius of the circle.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 20 is 5 marks)

9 In the diagram, ABC is a right-angled triangle and DEF is a semicircular arc.

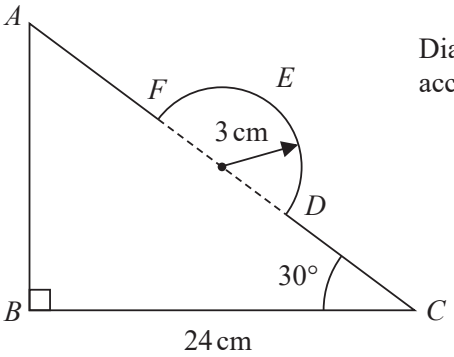


Diagram **NOT** accurately drawn

In triangle ABC

$BC = 24$ cm angle $ABC = 90°$ angle $BCA = 30°$

The points D and F lie on AC so that DF is the diameter of the semicircular arc DEF
The radius of the semicircular arc is 3 cm.

Work out the length of $AFEDC$
Give your answer correct to 2 significant figures.

..... cm

(Total for Question 9 is 5 marks)

19

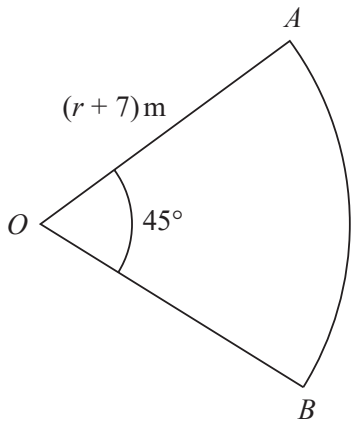


Diagram **NOT** accurately drawn

OAB is a sector **S** of a circle with centre *O* and radius $(r + 7)$ metres.
Angle *AOB* = 45°

A circle **C** has radius $(r - 2)$ metres.

The area of sector **S** is twice the area of circle **C**

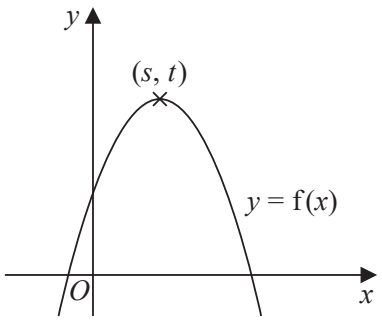
Find the value of *r*
Show your working clearly.

Question 19 continued.

$r =$ .....

(Total for Question 19 is 5 marks)

20 The diagram shows a sketch of part of the curve with equation $y = f(x)$



There is one maximum point on this curve.
The coordinates of this maximum point are (s, t)

Find, in terms of s and t, the coordinates of the maximum point on the curve with equation

(i) $y = f(x - 2)$

(..... , ...)

(1)

(ii) $y = 3f(x)$

(..... , ...)

(1)

(Total for Question 20 is 2 marks)

21 The diagram shows the cross section of a circular water pipe.

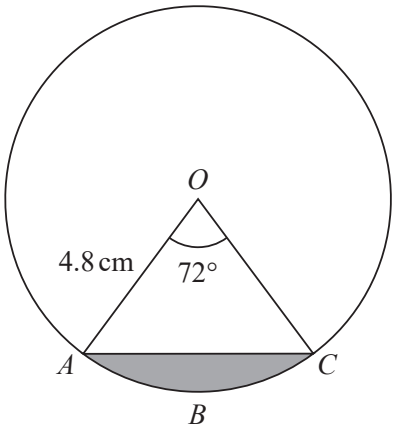


Diagram **NOT** accurately drawn

OABC is a sector of the circle, centre *O*

The shaded region in the diagram represents the water flowing in the pipe.

The water flows at 14 cm/s in the pipe.

Work out the volume of water that has flowed through the pipe in 3 minutes.
Give your answer in cm^3 correct to 3 significant figures.

..... cm^3

(Total for Question 21 is 5 marks)

Turn over for Question 22

4 The diagram shows a shape made up of three semicircles, enclosing a right-angled triangle.

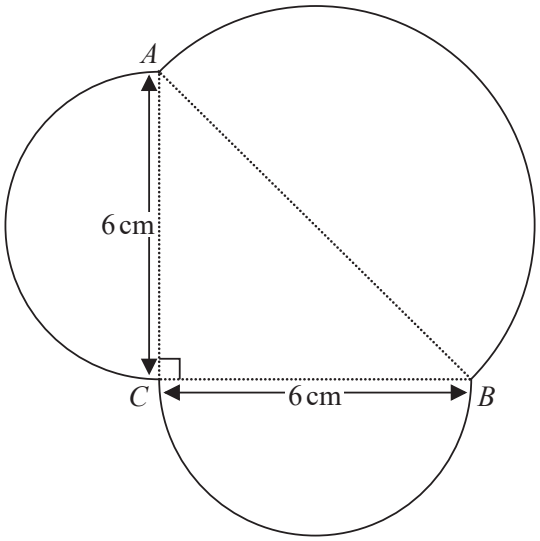


Diagram **NOT** accurately drawn

AB, BC and CA are each the diameter of a semicircle.

$BC = CA = 6$ cm.

Work out the perimeter of the shape.
Give your answer correct to one decimal place.

..... cm

(Total for Question 4 is 5 marks)

21 The diagram shows a square $ABCD$ and a circle.

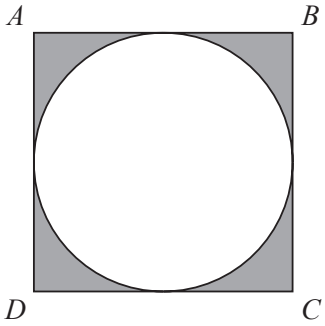


Diagram **NOT** accurately drawn

The sides of the square are tangents to the circle.

The total area of the shaded regions is $80\,\text{cm}^2$

Work out the length of AC
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 21 is 5 marks)

Turn over for Question 22

22

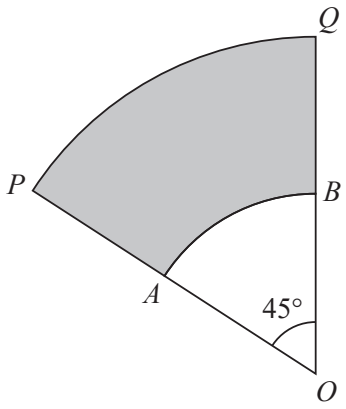


Diagram **NOT** accurately drawn

OPQ is a sector of a circle, centre O
OAB is a sector of a circle, centre O

A is the point on OP such that $OA : AP = 3 : 2$
B is the point on OQ such that $OB : BQ = 3 : 2$
Angle $POQ = 45°$

The area of the shaded region is $\frac{81}{2}\pi$ cm^2

Work out the perimeter of the shaded region.
Give your answer in terms of π.

cm

(Total for Question 22 is 6 marks)

Turn over for Question 23

19 The diagram shows a sector $OAPB$ of a circle, centre O.

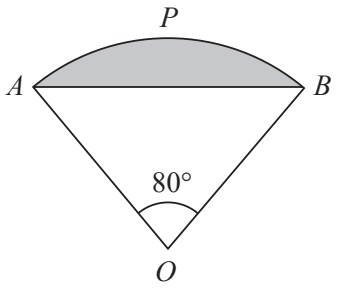


Diagram **NOT** accurately drawn

AB is a chord of the circle.
Angle $AOB = 80°$

The area of sector $OAPB$ is $\frac{25}{2}\pi \text{cm}^2$

Work out the perimeter of the shaded segment.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 19 is 6 marks)

22 The diagram shows a sector OBC of a circle with centre O and radius $(6 + x)$ cm.

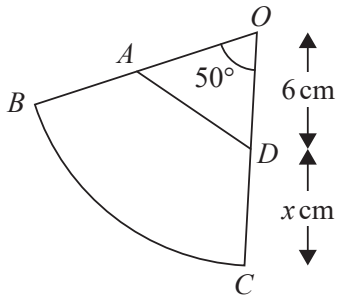


Diagram **NOT** accurately drawn

A is the point on OB and D is the point on OC such that $OA = OD = 6$ cm

Angle $BOC = 50°$

Given that

the perimeter of sector $OBC = 2 \times$ the perimeter of triangle OAD

find the value of x.
Give your answer correct to 3 significant figures.

$x =$ .....

(Total for Question 22 is 6 marks)

TOTAL FOR PAPER IS 100 MARKS

25 The diagram shows two circles such that the region **R**, shown shaded in the diagram, is the region common to both circles.

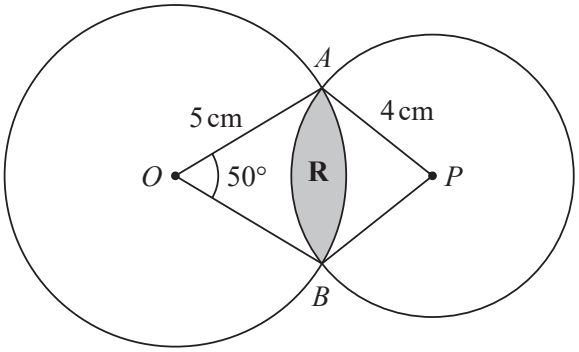


Diagram **NOT** accurately drawn

One of the circles has centre O and radius 5 cm.
The other circle has centre P and radius 4 cm.
Angle $AOB = 50°$

Calculate the area of region **R**.
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 25 is 6 marks)

Turn over for Question 26

22 The diagram shows two circles with centre O and a regular pentagon $ABCDE$

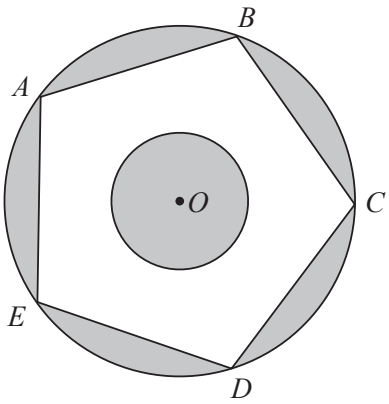


Diagram **NOT** accurately drawn

A, B, C, D and E are points on the larger circle.
The pentagon has sides of length 8 cm.

The diagram is shaded such that

shaded area = unshaded area

Work out the radius of the smaller circle.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 22 is 6 marks)

Turn over for Question 23

25

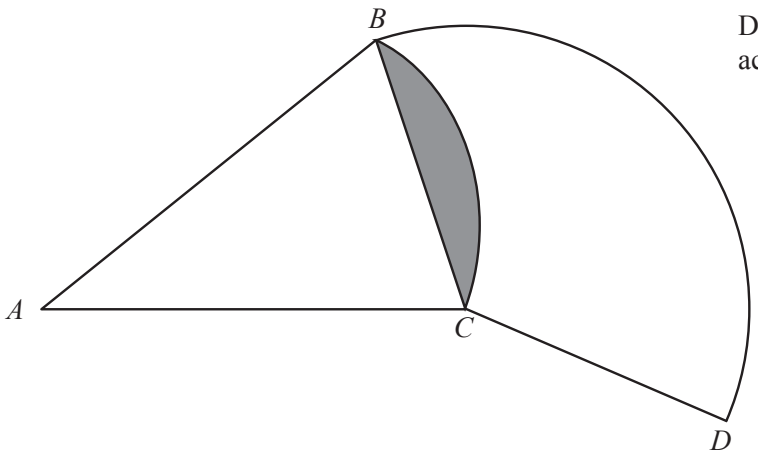


Diagram **NOT** accurately drawn

BAC is a sector of a circle, centre *A*

BCD is a sector of a circle, centre *C*

Angle *BAC* = 40°
Angle *BCD* = 130°
Area of shaded segment = 28 cm^2

Find the length of the arc *BD*
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 25 is 6 marks)

Turn over for Question 26

SUB-TOPIC G4c

VOLUME & SURFACE AREA

Sub-topic G4c · 48 questions · 209 marks · lowest tariff first

4 A cylinder has diameter 14 cm and height 20 cm.

Work out the volume of the cylinder.
Give your answer correct to 3 significant figures.

..... cm^3

(Total for Question 4 is 2 marks)

Answer ALL TWENTY SIX questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 (a) Simplify $\frac{x^9}{x^2}$

.....

(1)

(b) Write $\frac{7^8 \times 7^4}{7^3}$ as a single power of 7

.....

(2)

(Total for Question 1 is 3 marks)

2 Change 32.4 m^3 into cm^3

..... cm^3

(Total for Question 2 is 2 marks)

Answer ALL TWENTY FIVE questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 The diagram shows a cylinder.

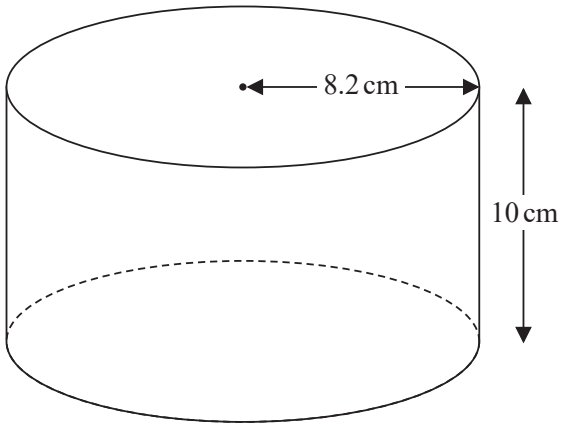


Diagram **NOT** accurately drawn

The cylinder has radius 8.2 cm and height 10 cm.
The cylinder is empty.

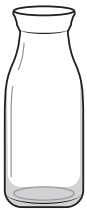
Pam pours 1.5 litres of water into the cylinder.

Work out the depth of the water in the cylinder.
Give your answer correct to 1 decimal place.

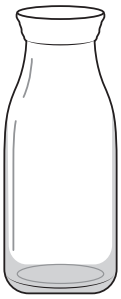
..... cm

(Total for Question 1 is 3 marks)

21 The diagram shows two similar bottles, **A** and **B**.



A



B

Diagram **NOT** accurately drawn

Bottle **A** has surface area 240 cm^2
Bottle **B** has surface area 540 cm^2 and volume 2025 cm^3

Work out the volume of bottle **A**.

..... cm^3

(Total for Question 21 is 3 marks)

13

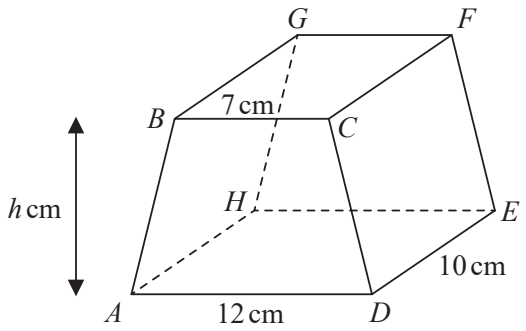


Diagram **NOT** accurately drawn

The diagram shows a prism *ABCDEFGH* in which *ABCD* is a trapezium with *BC* parallel to *AD* and *CDEF* is a rectangle.

BC = 7 cm *AD* = 12 cm *DE* = 10 cm

The height of trapezium *ABCD* is *h* cm
The volume of the prism is 608 cm^3

Work out the value of *h*.

h = ...

(Total for Question 13 is 3 marks)

2 The diagram shows a solid triangular prism.

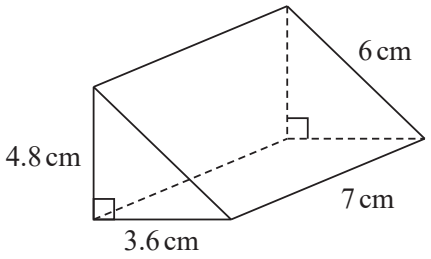


Diagram **NOT** accurately drawn

Work out the **total** surface area of the triangular prism.
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 2 is 3 marks)

21 Given that the surface area of a sphere is $49\pi\,\text{cm}^2$

find the volume of the sphere.
Give your answer correct to the nearest integer.

..... cm^3

(Total for Question 21 is 3 marks)

18 A statue and a model of the statue are mathematically similar.

The statue has a total surface area of 3600 cm^2
The model has a total surface area of 625 cm^2

The volume of the model is 750 cm^3

Work out the volume of the statue.

..... cm^3

(Total for Question 18 is 3 marks)

22 The diagram shows a bowl in the shape of a hemisphere.
The bowl is made from metal.

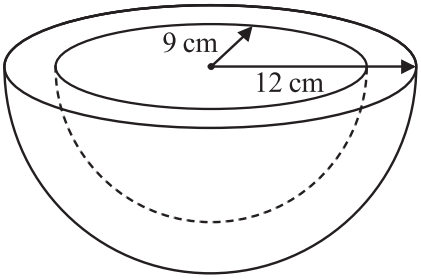


Diagram **NOT** accurately drawn

The outer radius of the bowl is 12 cm
The inner radius of the bowl is 9 cm

The thickness of the bowl is uniform.

Work out the volume of the metal.
Give your answer correct to the nearest whole number.

..... cm^3

(Total for Question 22 is 3 marks)

6 The diagram shows a solid triangular prism.

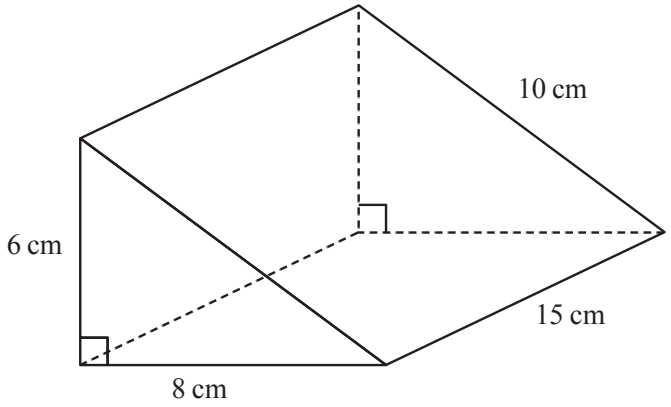


Diagram **NOT** accurately drawn

Work out the **total** surface area of the triangular prism.

..... cm^2

(Total for Question 6 is 3 marks)

7 Here is a solid cylinder.

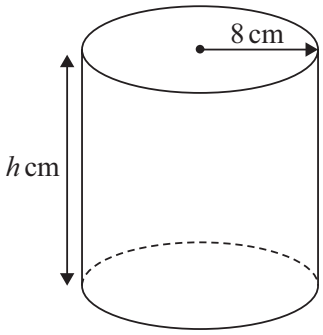


Diagram **NOT** accurately drawn

The radius of the cylinder is 8 cm
The height of the cylinder is h cm

The volume of the cylinder is 3892 cm^3

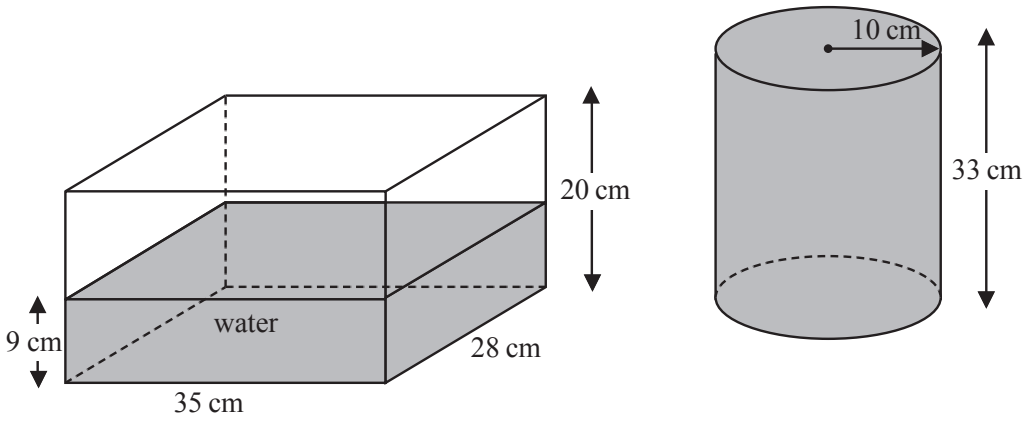
Work out the value of h
Give your answer correct to one decimal place.

$h =$ .....

(Total for Question 7 is 3 marks)

10 The diagram shows two water containers.
One is a cuboid and one is a cylinder.

Diagram **NOT** accurately drawn



The cuboid measures 35 cm by 28 cm by 20 cm
The surface of the water in the cuboid is 9 cm above the base of the cuboid.

The cylinder has a radius of 10 cm and a height of 33 cm
The cylinder is completely full of water.

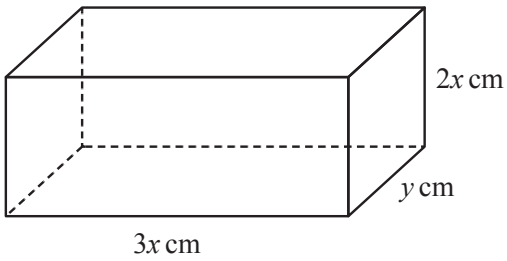
Izzy is going to pour all the water from the cylinder into the cuboid.

Show that the cuboid will not be completely full of water.

(Total for Question 10 is 3 marks)

21 The diagram shows a cuboid.

Diagram **NOT** accurately drawn



The cuboid measures $3x$ cm by $2x$ cm by y cm

The volume of the cuboid is 1014 cm³
The total surface area of the cuboid is A cm²

Show that $A = 12x^2 + \frac{1690}{x}$

You must show all the stages of your working.

(Total for Question 21 is 3 marks)

16 A frustum is made by removing a small cone from a large cone.
The cones are mathematically similar.

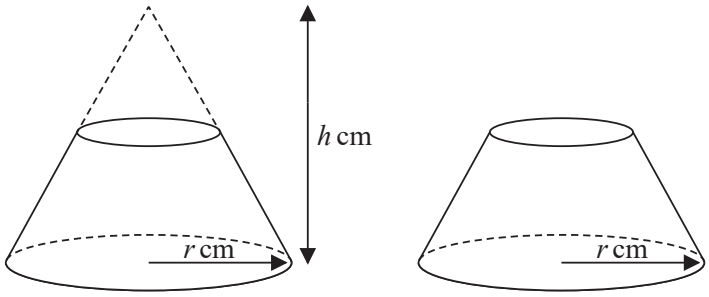


Diagram **NOT** accurately drawn

Frustum

The large cone has base radius r cm and height h cm.

Given that

$$\frac{\text{volume of frustum}}{\text{volume of large cone}} = \frac{98}{125}$$

find an expression, in terms of h, for the height of the frustum.

..... cm

(Total for Question 16 is 4 marks)

9 Here is an empty pool in the shape of a cuboid.

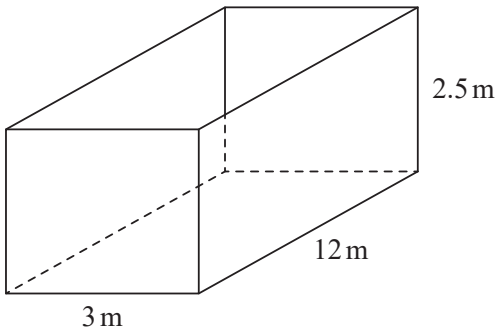


Diagram **NOT** accurately drawn

The width of the pool is 3 m.
The length of the pool is 12 m.
The top of the pool is 2.5 m above the base of the pool.

Jeb is going to put water in the pool.
The level of the surface of the water will be 60 cm below the top of the pool.

Water flows into the pool at 400 litres per minute.
$1\,m^3 = 1000$ litres

How long will it take to fill the pool to 60 cm below the top of the pool?
Give your answer in hours and minutes.

..... hours ..... minutes

(Total for Question 9 is 4 marks)

6 The diagram shows two cylinders, **A** and **B**.

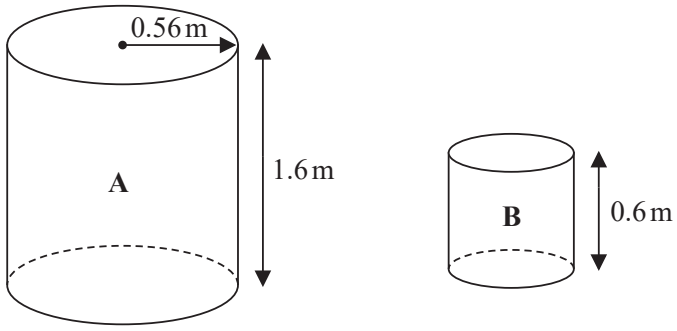


Diagram **NOT** accurately drawn

Cylinder **A** has height 1.6 m and radius 0.56 m.

(a) Work out the curved surface area of cylinder **A**.
Give your answer in m^2 correct to 3 significant figures.

..... m^2
(2)

Cylinder **B** is mathematically similar to cylinder **A**.
The height of cylinder **B** is 0.6 m.

(b) Work out the radius of cylinder **B**.

..... m
(2)

(Total for Question 6 is 4 marks)

15 The total surface area of a solid hemisphere is equal to the curved surface area of a cylinder.

The radius of the hemisphere is r cm.
The radius of the cylinder is twice the radius of the hemisphere.

Given that

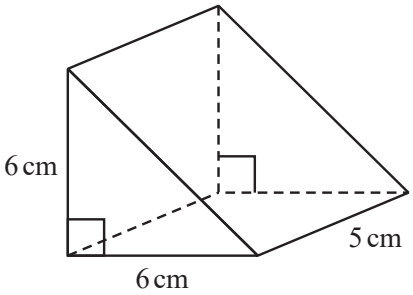
volume of hemisphere : volume of cylinder = 1 : m

find the value of m.

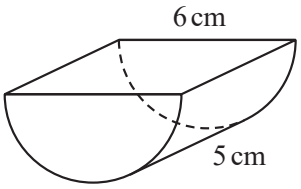
$m =$

(Total for Question 15 is 4 marks)

2 The diagram shows two solid toy bricks, Brick **A** and Brick **B**.



Brick **A**



Brick **B**

Diagram **NOT** accurately drawn

Brick **A** is a triangular prism of length 5 cm.
The cross section of Brick **A** is an isosceles right-angled triangle with equal sides of length 6 cm.

Brick **B** is half a cylinder of length 5 cm.
The semicircular cross section of Brick **B** has diameter 6 cm.

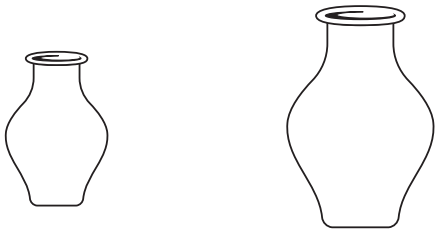
The volume of Brick **A** is greater than the volume of Brick **B**.

How much greater?
Give your answer correct to 1 decimal place.

cm^3

(Total for Question 2 is 4 marks)

17 **A** and **B** are two similar vases.



A **B**

Diagram **NOT** accurately drawn

Vase **A** has height 24 cm.
Vase **B** has height 36 cm.

Vase **A** has a surface area of 960 cm^2

(a) Work out the surface area of vase **B**.

..... cm^2
(2)

Vase **B** has a volume of $V cm^3$

(b) Find in terms of V, an expression for the volume, in cm^3, of vase **A**.

..... cm^3
(2)

(Total for Question 17 is 4 marks)

3 The diagram shows a container for water in the shape of a prism.

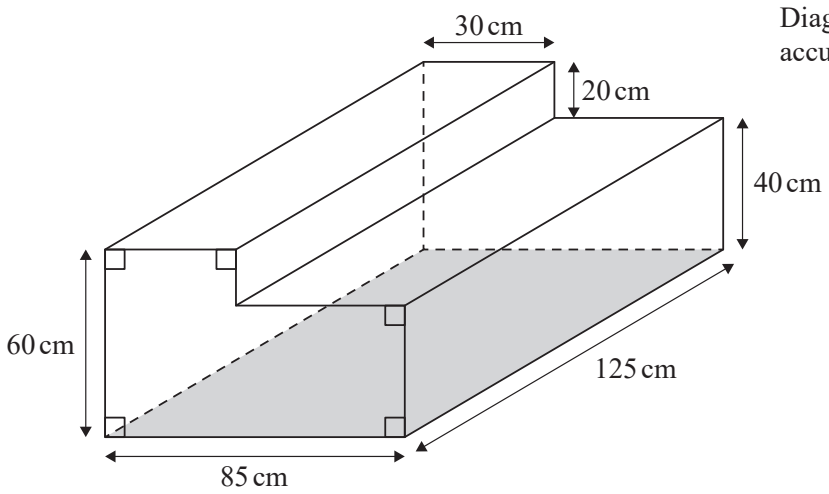


Diagram **NOT** accurately drawn

The rectangular base of the prism, shown shaded in the diagram, is horizontal.
The container is completely full of water.

Tuah is going to use a pump to empty the water from the container so that the volume of water in the container decreases at a constant rate.

The pump starts to empty water from the container at 10 30 and at 12 00 the water level in the container has dropped by 20 cm.

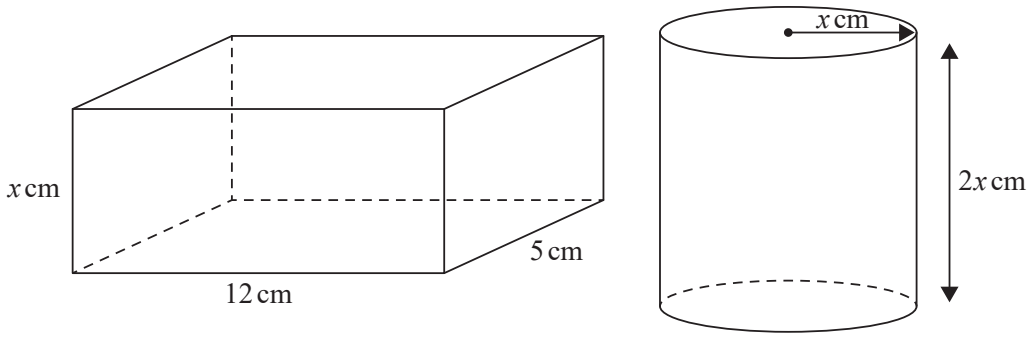
Find the time at which all the water has been pumped out of the container.

.....

(Total for Question 3 is 4 marks)

5 The diagram shows a cuboid and a cylinder.

Diagram **NOT** accurately drawn



The dimensions of the cuboid are x cm by 12 cm by 5 cm.
The volume of the cuboid is 270 cm^3

The radius of the cylinder is x cm.
The height of the cylinder is $2x$ cm.

(a) Work out the volume of the cylinder.
Give your answer correct to the nearest whole number.

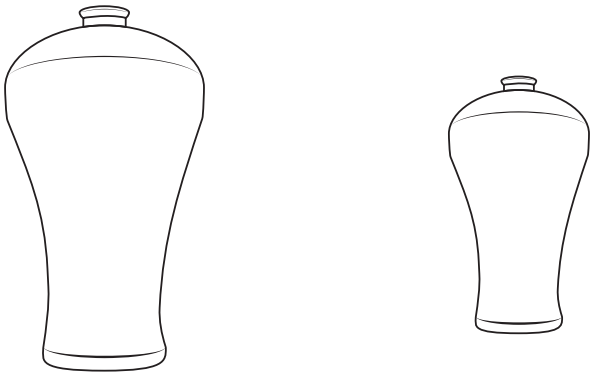
..... cm^3
(3)

(b) Change 1 m^3 to cm^3

..... cm^3
(1)

(Total for Question 5 is 4 marks)

19 **A** and **B** are two similar vases.



A **B**

Diagram **NOT** accurately drawn

The vases are such that

$$\text{surface area of vase } \mathbf{B} = \frac{25}{64} \times \text{surface area of vase } \mathbf{A}$$

and that

$$\text{volume of vase } \mathbf{A} - \text{volume of vase } \mathbf{B} = 541.8\,\text{cm}^3$$

Calculate the volume of vase **B**

..... cm^3

(Total for Question 19 is 4 marks)

6 The diagram shows a solid wooden cylinder.

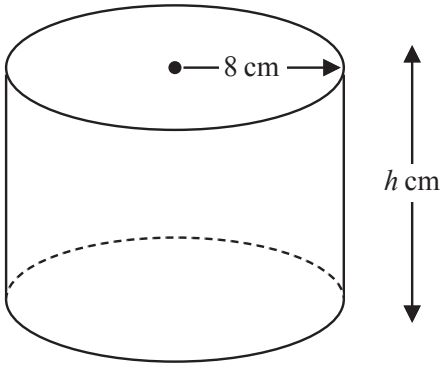


Diagram **NOT** accurately drawn

The cylinder has radius 8 cm and height h cm.
The volume of the cylinder is 1208 cm^3

(a) Work out the value of h
Give your answer correct to the nearest whole number.

$h =$ .....

(2)

The density of the wood is 1.25 g/cm^3

(b) Work out the mass of the cylinder.
Give your answer in kilograms.

..... kilograms

(2)

(Total for Question 6 is 4 marks)

5 The diagram shows a cylinder.

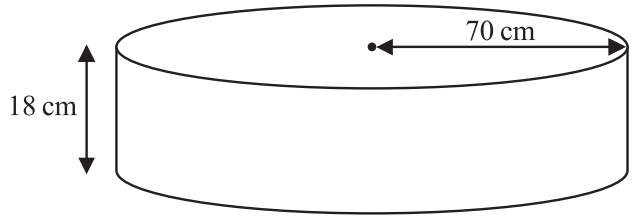


Diagram **NOT** accurately drawn

The radius of the cylinder is 70 cm
The height of the cylinder is 18 cm

Work out the volume of the cylinder.
Give your answer in litres correct to the nearest litre.

..... litres

(Total for Question 5 is 4 marks)

22 A 3-D shape consists of a hollow sphere made of metal.



The diagram shows a cross section drawn through the centre, O, of the sphere.

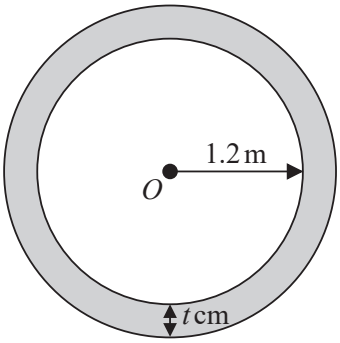


Diagram **NOT** accurately drawn

The internal radius of the sphere is 1.2 m.
The thickness of the metal is t cm.

The density of the metal is 2700 kg per m^3

The mass of the 3-D shape is 1980 kg.

Work out the value of t.
Give your answer correct to 2 significant figures.

$t =$ .....

(Total for Question 22 is 5 marks)

17 Here are a solid sphere and a solid cylinder.

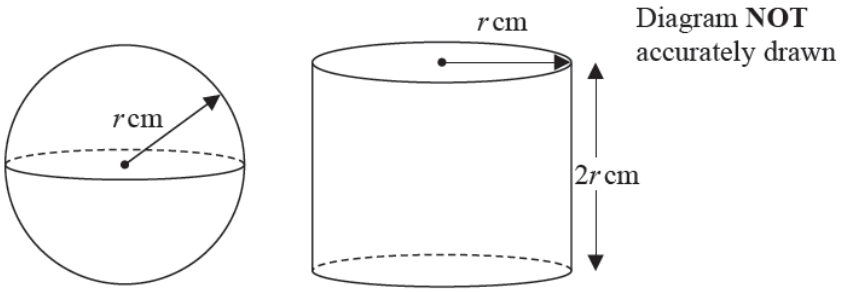


Diagram **NOT** accurately drawn

The radius of the sphere is r cm.
The radius of the cylinder is r cm.
The height of the cylinder is $2r$ cm.

The total surface area of the cylinder is $k\pi$ cm^2

(a) Find an expression for k in terms of r.

(2)

(b) Show that the ratio

total surface area of the cylinder : total surface area of the sphere

is the same as the ratio

volume of the cylinder : volume of the sphere

(3)

(Total for Question 17 is 5 marks)

18 Show that $\frac{\sqrt{8}}{\sqrt{8}-2}$ can be written in the form $n+\sqrt{n}$, where n is an integer.

Show your working clearly.

(Total for Question 18 is 3 marks)

21 A solid is made from a hemisphere and a cylinder.
The plane face of the hemisphere coincides with the upper plane face of the cylinder.

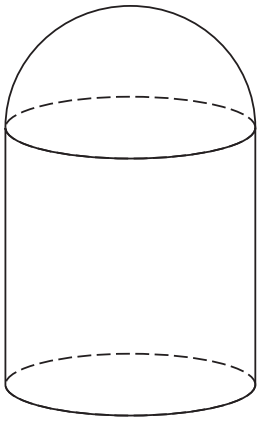


Diagram **NOT** accurately drawn

The hemisphere and the cylinder have the same radius.

The ratio of the radius of the cylinder to the height of the cylinder is 1 : 3

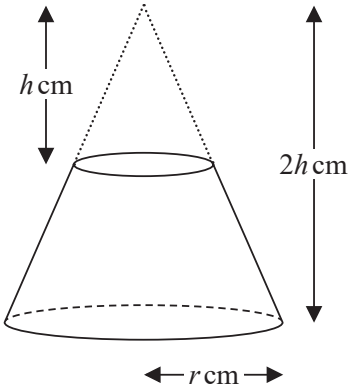
Given that the solid has volume $792\pi\,\text{cm}^3$
work out the height of the solid.

..... cm

(Total for Question 21 is 5 marks)

20 The diagram shows a frustum of a cone and a sphere.

The frustum is made by removing a small cone from a large cone.
The cones are similar.



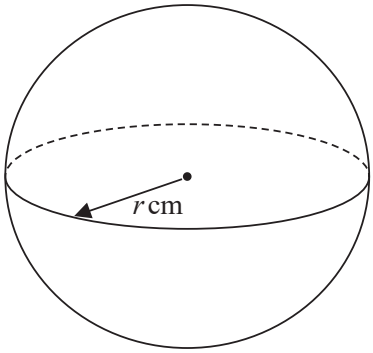


Diagram **NOT** accurately drawn

The height of the small cone is h cm.
The height of the large cone is $2h$ cm.
The radius of the base of the large cone is r cm.

The radius of the sphere is r cm.

Given that the volume of the frustum is equal to the volume of the sphere,

find an expression for r in terms of h.
Give your expression in its simplest form.

$r =$ .....

(Total for Question 20 is 5 marks)

9 The diagram shows a solid cylinder with radius 3 m.

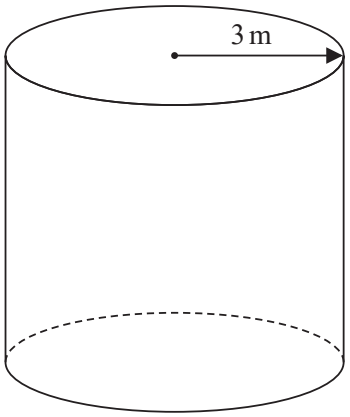


Diagram **NOT** accurately drawn

The volume of the cylinder is 72π m^3

Calculate the **total** surface area of the cylinder.
Give your answer correct to 3 significant figures.

..... m^2

(Total for Question 9 is 5 marks)

17 A solid, **S**, is made from a hemisphere and a cylinder.

The centre of the circular face of the hemisphere and the centre of the top face of the cylinder are at the same point.

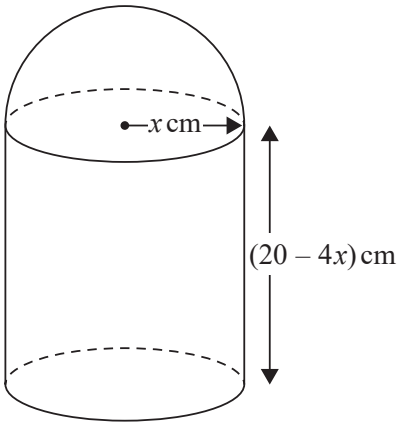


Diagram **NOT** accurately drawn

The radius of the cylinder and the radius of the hemisphere are both x cm.
The height of the cylinder is $(20 - 4x)$ cm.

The volume of **S** is V cm^3 where $V = \frac{1}{3}\pi y$

Find the maximum value of y.
Show clear algebraic working.

.....

(Total for Question 17 is 5 marks)

18 Given that $(8 - \sqrt{x})(5 + \sqrt{x}) = y\sqrt{x} + 21$ where x is a prime number and y is an integer,

find the value of x and the value of y.
Show each stage of your working clearly.

$x =$ .....

$y =$ .....

(Total for Question 18 is 3 marks)

10 Here is a triangular prism.

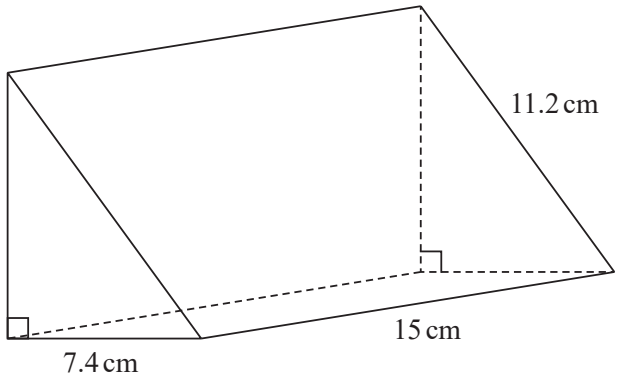


Diagram **NOT** accurately drawn

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

..... cm^3

(Total for Question 10 is 5 marks)

22 A solid is made from a cone and a hemisphere.

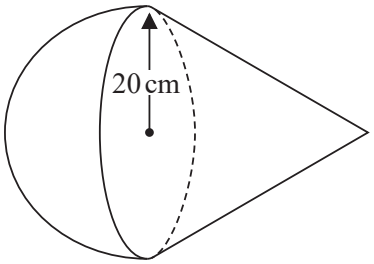


Diagram **NOT** accurately drawn

The circular plane face of the hemisphere coincides with the circular base of the cone.
The radius of the hemisphere and the radius of the circular base of the cone are both 20 cm.

The curved surface area of the cone is $580\pi\,\text{cm}^2$

The volume of the solid is $k\pi\,\text{cm}^3$

Work out the exact value of k

$k =$ .....

(Total for Question 22 is 5 marks)

23 The diagram shows a solid prism $ABCDEFGHIJ$

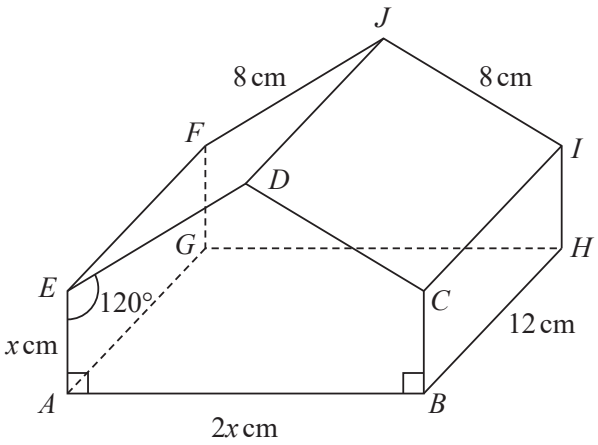


Diagram **NOT** accurately drawn

The prism is such that each cross section is a pentagon where

$AE = BC = x$ cm $\quad AB = 2x$ cm $\quad ED = CD = 8$ cm

angle EAB = angle $CBA = 90°$ angle AED = angle $BCD = 120°$

Given that $AG = BH = EF = DJ = CI = 12$ cm

calculate the angle that AJ makes with the base $ABHG$ of the prism.
Give your answer correct to 3 significant figures.

.....°

(Total for Question 23 is 5 marks)

Turn over for Question 24

23 A frustum is made by removing a small square-based pyramid from a similar large squared-based pyramid as shown in the diagram.

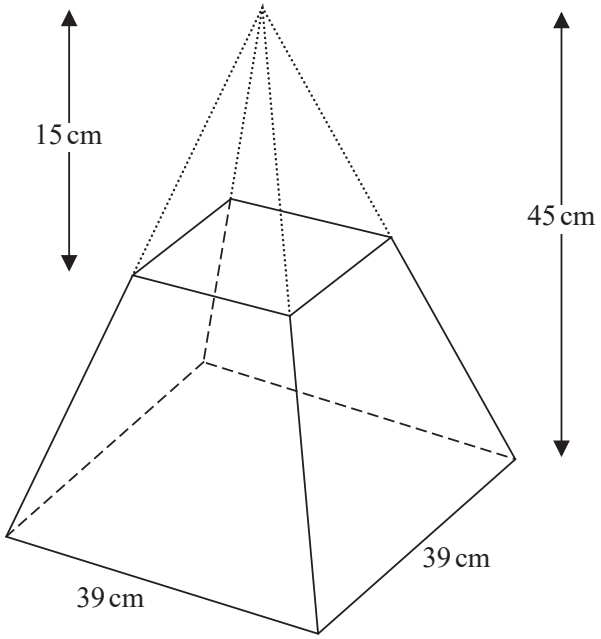


Diagram **NOT** accurately drawn

The height of the small pyramid is 15 cm.
The height of the large pyramid is 45 cm.
The square base of the large pyramid has side length 39 cm.

Work out the **total** surface area of the frustum.
Give your answer correct to the nearest whole number.

..... cm^2

(Total for Question 23 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS

24 The surface area of sphere **A** is nine times the surface area of sphere **B**
The difference between the volume of sphere **A** and the volume of sphere **B** is 117π cm^3

Find the radius of the smaller sphere.
Show your working clearly.

..... cm

(Total for Question 24 is 5 marks)

21 Here is a triangular prism $ABCDEF$

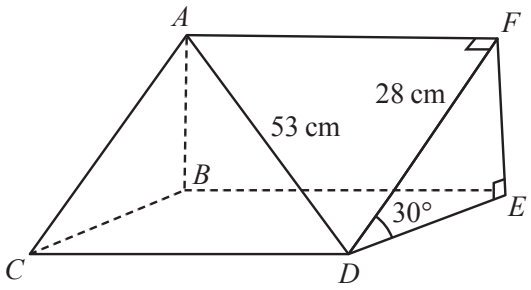


Diagram **NOT** accurately drawn

$AD = 53$ cm
$DF = 28$ cm
Angle $FDE = 30°$

Work out the volume of the triangular prism.
Give your answer correct to the nearest whole number.

..... cm^3

(Total for Question 21 is 5 marks)

23 Here is a frustum of a cone.
The frustum is made by removing a small cone from a similar large cone.

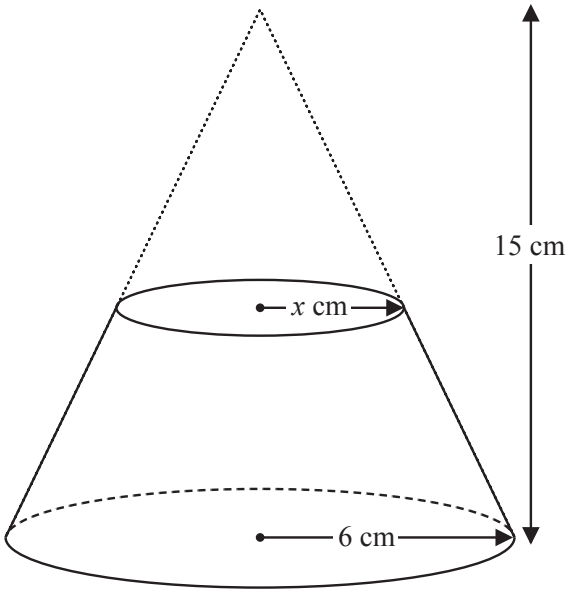


Diagram **NOT** accurately drawn

The height of the large cone is 15 cm.

The radius of the base of the large cone is 6 cm.
The radius of the base of the small cone is x cm.

Given that the volume of the frustum is $\frac{4212}{25}\pi$ cm^3

work out the value of x
Show clear algebraic working.

$x =$ .....

(Total for Question 23 is 5 marks)

Turn over for Question 24

23 A solid shape is made by removing a hemisphere, shown shaded, from a cone as shown in the diagram.

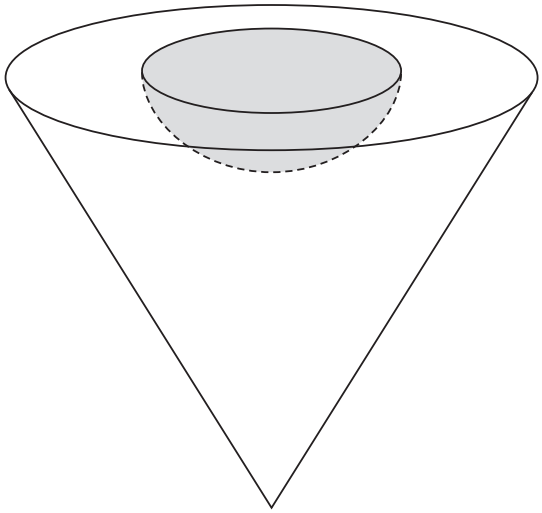


Diagram **NOT** accurately drawn

The radius of the hemisphere is $2x$ cm
The radius of the base of the cone is $5x$ cm
The vertical height of the cone is $6x$ cm

The volume of the solid shape is 6948π cm^3

Work out the **total** surface area of the solid hemisphere that has been removed from the cone.
Give your answer correct to the nearest integer.

..... cm^2

(Total for Question 23 is 5 marks)

24 The diagram shows a solid, **S**, made from a cone and a hemisphere.

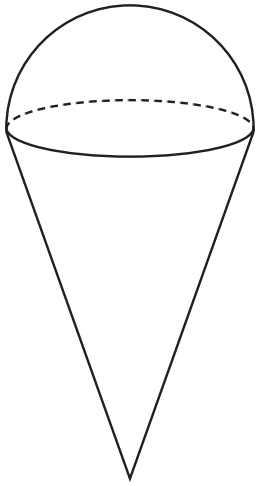


Diagram **NOT** accurately drawn

The centre of the circular face of the cone coincides with the centre of the flat surface of the hemisphere.

The radius of the circular face of the cone, x cm, is equal to the radius of the hemisphere.

The total height of **S** is 4 × the radius of the hemisphere.

A separate sphere has radius kx cm.
The volume of this sphere is 12.5 × the volume of **S**

(a) Work out the value of k

$k =$ .....

(4)

A solid, **T**, is similar to solid **S**

The volume of **T** is 512 × the volume of **S**

The total surface area of **T** is d × the total surface area of **S**

(b) Find the value of d

$d =$ .....

(1)

(Total for Question 24 is 5 marks)

Turn over for Question 25

26 The diagram shows a solid hemisphere, H

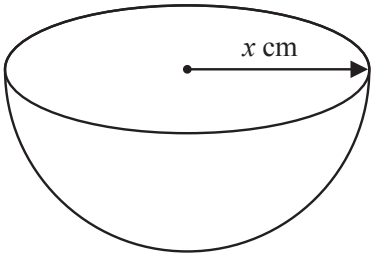


Diagram **NOT** accurately drawn

The radius of H is x cm
The volume of H is 6174π cm^3

A bowl is made by removing a solid hemisphere from H such that the uniform thickness of the bowl is 2 cm

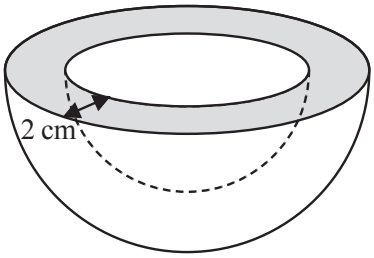


Diagram **NOT** accurately drawn

Work out the **total** surface area of the bowl.
Give your answer in terms of π

..... cm^2

(Total for Question 26 is 5 marks)

TOTAL FOR PAPER IS 100 MARKS

22 The diagram shows a cone.

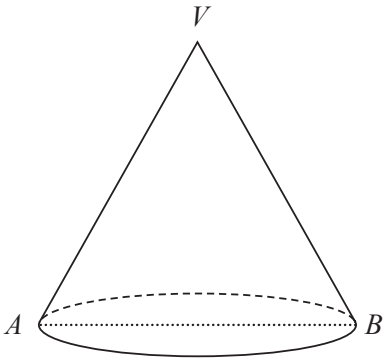


Diagram **NOT** accurately drawn

AB is a diameter of the cone.
V is the vertex of the cone.

Given that

the area of the base of the cone : the total surface area of the cone = 3 : 8

work out the size of angle AVB.
Give your answer correct to 1 decimal place.

°

(Total for Question 22 is 6 marks)

26 Here is a sector, AOB, of a circle with centre O and angle $AOB = x°$

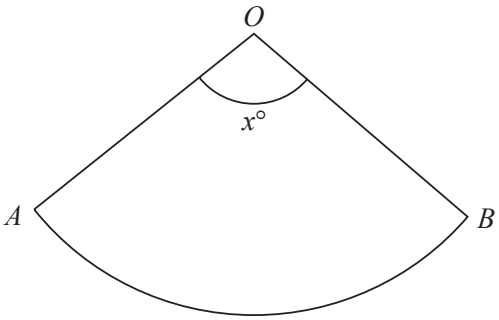


Diagram **NOT** accurately drawn

The sector can form the curved surface of a cone by joining OA to OB.

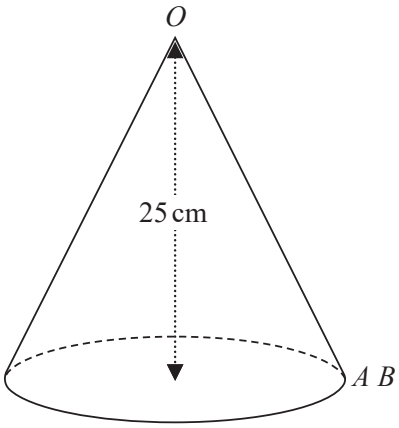


Diagram **NOT** accurately drawn

The height of the cone is 25 cm.
The volume of the cone is 1600 cm^3

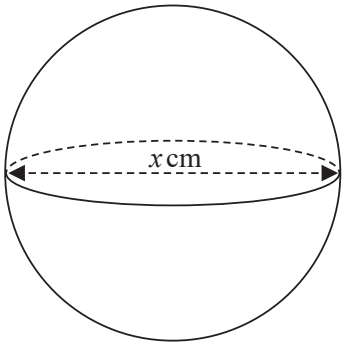
Work out the value of x.
Give your answer correct to the nearest whole number.

$x =$ .....

(Total for Question 26 is 6 marks)

TOTAL FOR PAPER IS 100 MARKS

22 The diagram shows a sphere of diameter x cm and a pyramid $ABCDE$ with a horizontal rectangular base $BCDE$.



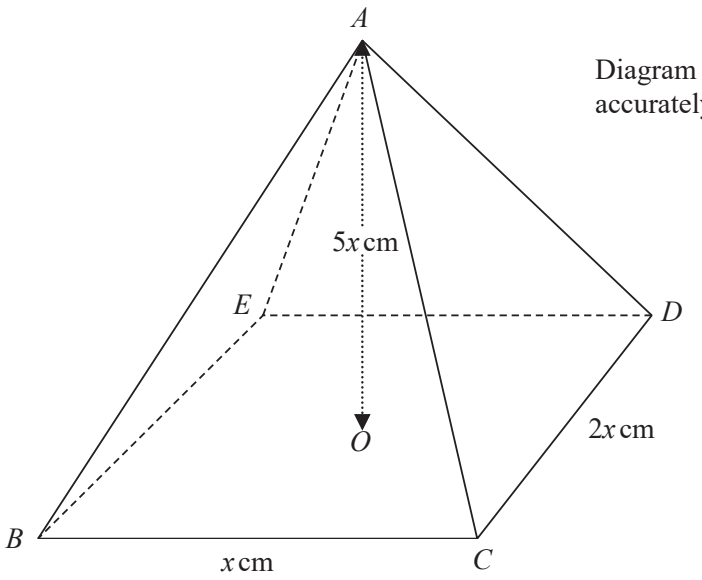


Diagram **NOT** accurately drawn

The vertex A of the pyramid is vertically above the centre O of the base so that $AB = AC = AD = AE$.

$BC = x$ cm, $CD = 2x$ cm and $AO = 5x$ cm.

The volume of the sphere is 288π cm^3

Calculate the total surface area of the pyramid.
Give your answer correct to the nearest cm^2

..... cm^2

(Total for Question 22 is 6 marks)

TOTAL FOR PAPER IS 100 MARKS

10 Jonty has a storage container in the shape of a cuboid, as shown in the diagram.

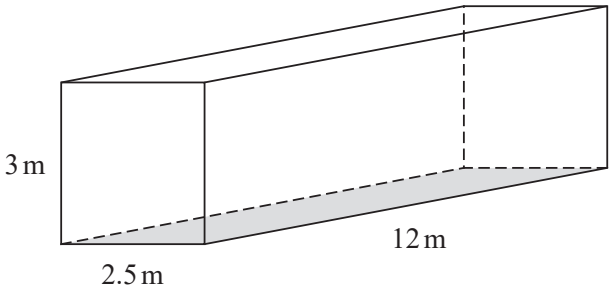


Diagram **NOT** accurately drawn

Jonty is going to paint the outside of his storage container, apart from the base which is shown shaded in the diagram.
He needs enough paint to cover the four sides and the top.

Each tin of paint covers an area of 15 m^2

The cost of each tin of paint recently increased by 10%
After the increase, the cost of each tin of paint is £26.95

Jonty says

"**Before** the increase, I could have bought enough paint for less than £200"

Show that Jonty is correct.
Show your working clearly.

(Total for Question 10 is 6 marks)

21 The diagram shows a solid made from a cylinder and a hemisphere.
The cylinder and the hemisphere are both made from the same metal.

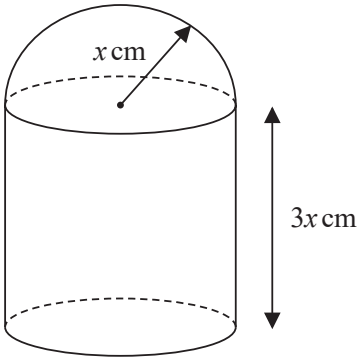


Diagram **NOT** accurately drawn

The plane face of the hemisphere coincides with the upper plane face of the cylinder.

The radius of the cylinder and the radius of the hemisphere are both x cm.
The height of the cylinder is $3x$ cm.

The total surface area of the solid is 81π cm^2
The mass of the solid is 840 grams.

The following table gives the density of each of four metals.

Metal	Density (g/cm^3)
Aluminium	2.7
Nickel	8.9
Gold	19.3
Silver	10.5

The metal used to make the solid is one of the metals in the table.

Determine the metal used to make the solid.
Show your working clearly.

.....

(Total for Question 21 is 6 marks)

Turn over for Question 22

24 The diagram shows a frustum of a cone, and a sphere.

The frustum, shown shaded in the diagram, is made by removing the small cone from the large cone.
The small cone and the large cone are similar.

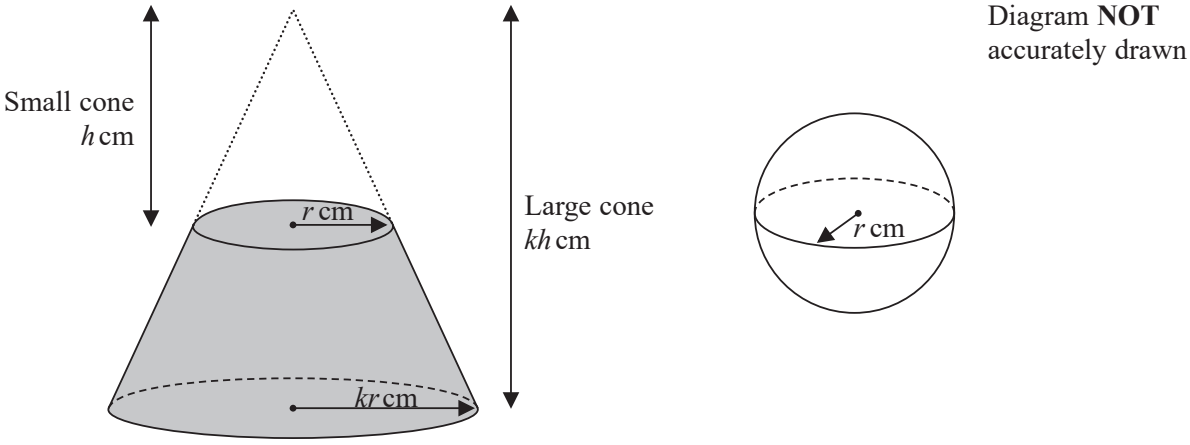


Diagram **NOT** accurately drawn

The height of the small cone is h cm and the radius of the base of the small cone is r cm.
The height of the large cone is kh cm and the radius of the base of the large cone is kr cm.
The radius of the sphere is r cm.

The sphere is divided into two hemispheres, each of radius r cm.

Solid **A** is formed by joining one of the hemispheres to the frustum.
The plane face of the hemisphere coincides with the upper plane face of the frustum, as shown in the diagram below.

Solid **B** is formed by joining the other hemisphere to the small cone that was removed from the large cone.
The plane face of the hemisphere coincides with the plane face of the base of the small cone, as shown in the diagram below.

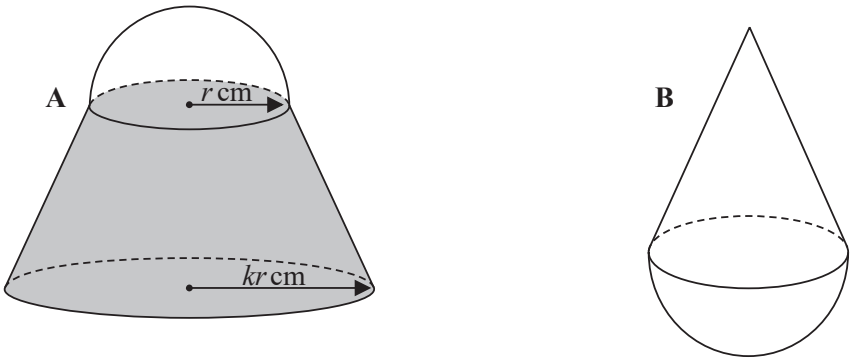


Diagram **NOT** accurately drawn

The volume of solid **A** is 6 times the volume of solid **B**.

Given that $k > \sqrt[3]{7}$

find an expression for h in terms of k and r

$h =$ .....

(Total for Question 24 is 6 marks)

24 The diagram shows a solid cone and a solid sphere.

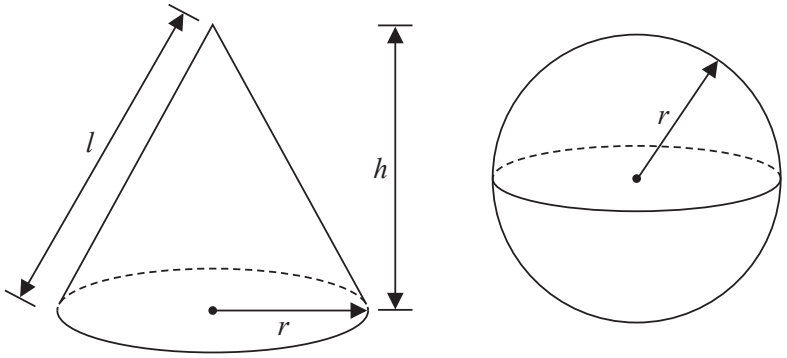


Diagram **NOT** accurately drawn

The cone has base radius r, slant height l and perpendicular height h
The sphere has radius r

The base radius of the cone is equal to the radius of the sphere.

Given that

$$k \times \text{volume of the cone} = \text{volume of the sphere}$$

show that the **total** surface area of the cone can be written in the form

$$\pi r^2 \left(\frac{k + \sqrt{k^2 + a}}{k} \right)$$

where a is a constant to be found.

(Total for Question 24 is 6 marks)

Turn over for Question 25

9 The diagram shows a rectangular sheet of metal $ABCD$

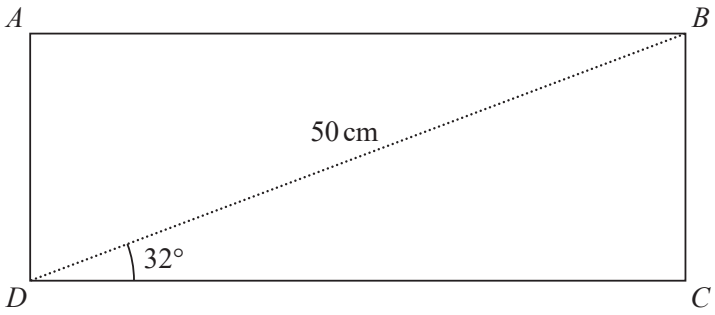


Diagram **NOT** accurately drawn

$BD = 50$ cm and angle $BDC = 32°$

Nasser joins side AD to side BC to form a cylinder.

BC is the height of the cylinder.
DC is the circumference of the cross section of the cylinder.

Work out the volume, in cm^3, of the cylinder.
Give your answer correct to 3 significant figures.

..... cm^3

(Total for Question 9 is 6 marks)

MARK SCHEMES

official mark schemes, in the same order as the questions

International GCSE Maths 4MA1 1HR

Q	Working	Answer	Mark	Notes
1	20 × 14 (= 280)	460	4	M1
	$\frac{20+16}{2} \times (24-14)$ (= 180)			M1
	"280" + "180"			M1 (dep) on at least one of the previous M marks
				A1
				Total 4 marks
	Alternative scheme 1			
	(24 +14)÷2 (= 19) **and** (20−16)÷2 (=2)	460	4	M1
	2 × 19 (= 38) **and** 16 × 24 (= 384)			M1
	"38" + "38" + "384"			M1 (dep) on at least one of the previous M marks
				A1
				Total 4 marks
	Alternative scheme 2			
	20 × 24 (= 480)	460	4	M1
	(20−16)÷2 (=2) **and** 24 − 14 (= 10) 2 × 10 = 20			M1
	"480" – "20"			M1 (dep) on at least one of the previous M marks
				A1
				Total 4 marks

3		E.g. 12×9 (=108) **or** $(9 - 6) \times x$ (= $3x$)		4	M1 for one correct relevant area
		E.g. 129 – '108' (= 21) **or** '108' + '$3x$' = 129			M1 (dep on M1) for 129 used correctly with another area **or** for a correct equation (ft) with bracket(s) expanded
		E.g. '21' ÷ (9 – 6) **or** $x = \frac{129 - '108'}{9 - 6}$			M1 for a complete method
			7		A1 Accept 7 cm
					Total 4 marks

20	eg $0.5 \times x \times x \times \sin 60$ $\left(=\frac{\sqrt{3}}{4}x^2 = 0.433...x^2\right)$ oe where $x = PQ$ eg $0.5 \times 2n \times 2n \times \sin 60 \left(=\sqrt{3}n^2 = 1.732...n^2\right)$ oe where $2n = PQ$ or use $0.5 \times b \times h$ where $h = \sqrt{x^2 - (0.5x)^2} \left(=\frac{\sqrt{3}}{2}x\right)$ oe		4	M1 For expression for area of triangle [using $AB = x$ and $PQ = \frac{2}{3}x$ gives $\frac{\sqrt{3}}{9}x^2 = 0.192...x^2$] (correct expression in 1 variable eg PQ)
	eg $6 \times 0.5 \times 1.5x \times 1.5x \times \sin 60$ $\left(=\frac{27\sqrt{3}}{8}x^2 = 5.845...x^2\right)$ oe eg $6 \times 0.5 \times 3n \times 3n \times \sin 60$ $\left(=\frac{27\sqrt{3}}{2}n^2 = 23.382...n^2\right)$ oe or eg $2\left(\frac{1}{2} \times 1.5x \times 1.5x \times \sin 120\right) + 1.5x \times AE$ where $AE = \sqrt{(1.5x)^2 + (1.5x)^2 - 2 \times 1.5x \times 1.5x \times \cos 120}$ $\left(=\frac{27\sqrt{3}}{8}x^2 = 5.845...x^2\right)$ or use of $6 \times 0.5 \times b \times h$, finding h by Pythagoras			M1 for expression for area of hexagon [using $AB = x$ and $PQ = \frac{2}{3}x$ gives $\frac{3\sqrt{3}}{2}x^2 = 2.598...x^2$] (correct expression in 1 variable eg AB)
	eg $6 \times 0.5 \times 1.5x \times 1.5x \times \sin 60 - 0.5 \times x \times x \times \sin 60 = 72\sqrt{3}$ oe **or** $\left(\frac{27\sqrt{3}}{8} - \frac{\sqrt{3}}{4}\right)x^2 = 72\sqrt{3}$ **or** $(5.845\ldots - 0.433\ldots)x^2 = 124.7\ldots$ **or** eg $6 \times 0.5 \times 3n \times 3n \times \sin 60 - 0.5 \times 2n \times 2n \times \sin 60 = 72\sqrt{3}$ oe $\left(\frac{27\sqrt{3}}{2} - \sqrt{3}\right)n^2 = 72\sqrt{3}$ or $(23.382\ldots - 1.732\ldots)n^2 = 124.7\ldots$			M1 for a correct equation for shaded area (correct equation in 1 variable, eg PQ or x etc)
		4.8		A1

3	$8 \times x$ (= $8x$) **or** $14 \times x$ (= $14x$) **or** $(14 - 8) \times x$ (= $6x$) **or** ½ × (14 – 8) × (13 – x) (= 39 – $3x$) **or** $\frac{13+x}{2} \times (14-8) (= 39 + 3x)$ **or** ½ × 13 × (14– 8) (=39) **or** $\frac{8+14}{2} \times x$ (= $11x$) **or** 14 × 13 (=182) **or** 8 × (13 – x) (= 104 – $8x$) **or** $\left(\frac{8+14}{2} \times (13-x)\right)$ (= 143 – $11x$) oe		4	M1 one correct area linked to the shape
	$14x + 6 \times$ ½ × (13 – x) oe eg $8x + \frac{x+13}{2} \times 6$ **or** $\frac{8+14}{2} \times x + \frac{13 \times (14-8)}{2}$ **or** "182" – $\left(\frac{8+14}{2} \times (13-x)\right)$ **or** $11x + 39$ oe			M1 ft from correct working expression for total area of shape – with no parts omitted or duplicated Adding up parts of given shape **or** large rectangle subtracting trapezium (or subtracting (rectangle + triangle))
	eg $11x + 39 = 91.8$ **or** $14x + 39 - 3x = 91.8$ **or** $182 - 143 + 11x = 91.8$ **or** $16x + 6x + 78 = 183.6$ oe			M1 fully correct equation with no fractions (allow 91.8 or multiples of 91.8 but no other decimals) **and** no brackets
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	4.8		A1 **or** $4\frac{4}{5}$ oe **or** $\frac{24}{5}$ oe
				Total 4 marks

2	$4 \times (5 - x)$ **or** $5 \times (2x - 1)$ **or** $20 - 4x$ **or** $10x - 5$ oe			4	M1	for setting up a correct algebraic expression for area A or area B (could be seen as part of an equation) (condone lack of brackets for multiplying if meaning is clear for this mark only)
	one from: $4(5 - x) = 20 - 4x$ or $2 \times 4(5 - x) = 40 - 8x$ or $0.5 \times 4(5 - x) = 10 - 2x$ oe	**and** one from: $5(2x - 1) = 10x - 5$ or $2 \times 5(2x - 1) = 20x - 10$ or $0.5 \times 5(2x - 1) = 5x - 2.5$ oe			M1	for expanding 2 sets of brackets correctly (one for each shape) [allow ×2 or ÷2 for the wrong shape for this mark] Need not be in an equation at this stage.
	eg $10x + 8x = 40 + 5$ **or** $-5 - 40 = -10x - 8x$ **or** $18x = 45$ **or** $-45 = -18x$ **or** $4x + 5x = 20 + 2.5$ oe				M1	for a correct equation with terms in x on one side and number terms the other side
	Working required		2.5		A1	oe dep on M1
						Total 4 marks

4	$\frac{16}{3}(-)\frac{20}{7}$ or $(5)\frac{7}{21}(-)(2)\frac{18}{21}$		3	M1	for correct improper fractions or fractional part of numbers written correctly over a common denominator (no need for minus sign)
	$\frac{112}{21}-\frac{60}{21}$ or $5\frac{7}{21}-2\frac{18}{21}=3-\frac{11}{21}$ oe or $5\frac{7}{21}-2\frac{18}{21}=4\frac{28}{21}-2\frac{18}{21}$			M1	for correct fractions with a common denominator with minus sign or mixed numbers to the stage shown
	$\frac{112}{21}-\frac{60}{21}=\frac{52}{21}=2\frac{10}{21}$ oe or $3-\frac{11}{21}=2\frac{10}{21}$ or $5\frac{7}{21}-2\frac{18}{21}=4\frac{28}{21}-2\frac{18}{21}=2\frac{10}{21}$	Shown		A1	Dep on M2 for a correct answer from fully correct working If all 3 fractions turned into improper fractions on the first line $\frac{16}{3}-\frac{20}{7}=\frac{52}{21}$ then the student **clearly** needs to show that the LHS $=\frac{52}{21}$
					Total 3 marks

5	28 × 12 (=336) or 5 × 12 (= 60) or 18 × 12 (= 216) or 28 × 20 (=560) or $\frac{1}{2}(CD+"18")"8"$ oe eg $72+4CD$ [numbers in " " come from correct working] **Check diagram for areas**		4	M1	For a correct method to find the area of a rectangle (may be seen as part calculation) or a correct expression for the area of the trapezium with numbers substituted. Allow for other correct methods to find area linked to this shape.
	"336" + 0.5("18"+ *CD*)"8" = 434 oe eg 4("18" + *CD*) = 98 or eg 0.5("18" + *CD*)"8" = "98" oe eg $\frac{1}{2}(18+CD)=12.25$ or $"560"-2\left(0.5(5+x)"8"\right)=434$ oe (where *x* is horizontal from *D* to perp with *AF*) [numbers in " " come from correct working]			M1	correct use of their values from correct working for an equation involving *CD* (*CD* could be labelled with any letter)
	eg $(CD=)\frac{196-144}{8}\left(=\frac{52}{8}\right)$ or $(CD=)\frac{98-72}{4}\left(=\frac{26}{4}\right)$ or $(CD=)\frac{434+152-560}{4}$ or $(CD=)2\times12.25-18$ or $98\times2(=196)$, $"196"\div8(=24.5)$, $"24.5"-18$			M1	a correct process to solve a correct equation **or** a correct process to find *CD* using **correct values**
		6.5		A1	oe
					Total 4 marks

Award M1A1 in (i) and B0 in (ii)
What if they factorise correctly and then expand and give the original expression on the answer line – award full marks; the student knows how to factorise and is checking and gives their check as the answer.

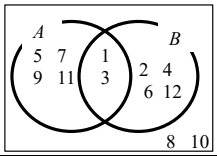
9	$\frac{1}{2}\times 7\times h = 42$ oe or $(h=)\frac{42\times 2}{7}$ (= 12) oe or $3.5^2+h^2=y^2$ or $h=\sqrt{y^2-3.5^2}$ oe		4	M1	A correct equation involving the height or a correct expression for height – could be in terms of y
	$y^2=\left(\frac{7}{2}\right)^2+("12")^2$ oe or $\frac{1}{2}\times 7\times "\sqrt{y^2-3.5^2}" = 42$ oe			M1	(indep) use of *their* height (any found value that they have called 'height')
	$y=\sqrt{\left(\frac{7}{2}\right)^2+("12")^2}$ oe			M1	**all values must come from a correct method**
	Correct answer scores full marks (unless from obvious incorrect working)	12.5		A1	oe eg $\frac{25}{2}$
					Total 4 marks

Question	Working	Answer	Mark	Notes
4	eg $5x-1=3x+7.4$ oe **or** eg $10x-2+48$ **or** $6x+14.8+48$ **or** $24+24+5x-1+3x+7.4$ oe		4	M1 a correct equation to find x **or** a correct expression for the perimeter in terms of x
	$x=4.2$			A1 the correct value of x (implies previous mark)
	$2\times24+2(5\times$ "4.2" $-1)$ oe **or** $2\times24+2(3\times$ "4.2" $+7.4)$ oe **or** $2\times24+(5\times4.2-1)+(3\times4.2+7.4)$ oe eg $24+24+20+20$ oe			M1dep on a correct method to find the perimeter – use of positive x from correct working (1st M1 awarded for an equation) **and** only if used the same measurement for AD and BC
	working required	88		A1 cao dep on either M1 or $x=4.2$
				Total 4 marks

Question		Working	Answer	Mark	Notes
5	(a)		2.745	1	B1
	(b)		2.755	1	B1 allow $2.754\dot{9}$
	(c)	$(80\times60)\div2^2$		2	M1 For two of 80, 60, 2 or 4 rather than 2^2 oe
		eg $(80\times60)\div2^2=1200$ oe *working with rounded values seen required*	1200		A1 dep on M1 for answer coming from use of the 3 rounded numbers – if 1200 seen then ignore any other working and comments
					Total 4 marks

5	$\frac{1}{2}(330+170)\times 240$ (= 60 000) oe or $\left(\frac{80\times 240}{2}\right)+(170\times 240)+\left(\frac{80\times 240}{2}\right)$ (= 60 000) oe or (2 × 9600) + 40 800 (= 60 000) oe		4	M1 for working out the area of the trapezium
	[60 000] ÷ 10 000 (= 6) or 10 000 × 6 (= 60 000)			M1 ft their area (must come from a two dimensional area) Allow $\frac{\text{their area}}{10\,000}$
	49 650 ÷ [6]			M1 dep on either previous M1 ft their number of hectares Allow $\frac{49\,650}{\text{their number of hectares}}$
	Correct answer scores full marks (unless from obvious incorrect working)	8275		A1
				Total 4 marks

7	eg 13×21 (=273) **or** $21 \times h$ (= $21h$) **or** $0.5(15 + 21) \times y$ **or** $15(h - 13)$ **or** $2 \times ½(3(h - 13))$ **or** $½(13 + h) \times 3$ (= $19.5 + 1.5h$) **or** $15 \times h$ (= $15h$)		4	M1	A correct calculation for an area linked to the shape. ($h - 13$) might be written as x or y etc: this is acceptable (even allow h) [allow without brackets for this mark only]
	eg $390 - "273"$ (= 117) **or** 13×21 **and** $0.5(15 + 21)(h - 13)$ **or** 13×21 **and** $0.5(15 + 21)y$ oe **or** $21h$ **and** $2 \times ½(3(h - 13))$ oe **or** 13×21 **and** $15(h - 13)$ **and** $2 \times ½(3(h - 13))$ oe **or** $2 \times ½(13 + h) \times 3$ **and** $15 \times h$			M1	For considering the area of all parts of the shape (parts need not be added or subtracted for the whole shape) (where y = height of $BCDE$) ($h - 13$) might be written as x or y etc: this is acceptable (even allow h) [correct use of brackets]
	"117" ÷ (0.5 × (15 + 21))(= 6.5) or **or** $\frac{1}{2}(15 + 21) \times y = "117"$ **or** $273 + 18(h - 13) = 390$ **or** $15(h - 13) + 2 \times ½(3(h - 13)) =$"117" oe **or** $2 \times ½(13 + h) \times 3 + 15h = 390$ **Typical equations here simplify to :** $18y = 117$, $18h - 234 = 117$, $18h + 39 = 390$, $18h = 351$			M1	A correct calculation to find height of trapezium or height of shape or a correct equation involving height of trapezium or height of shape or 6.5 ($h - 13$) might be written as x or y etc: this is acceptable (even allow h) [correct use of brackets]
	Correct answer scores full marks (unless from obvious incorrect working)	19.5		A1oe	eg $\frac{39}{2}$
					Total 4 marks

Question	Working	Answer	Mark	Notes
4		Fully correct Venn diagram	4	B4 fully correct Venn diagram with labels *A* and *B* (If not B4 then B3 for 3 correct regions, B2 for 2 correct regions B1 for 1 correct region)
5	123 – 67 (=56) **or** $2x = 123 – 67$ **or** $2x + y = 67$ **or** $4x + y = 123$ oe (x = length of tile, y = width of tile) e.g. "56" ÷ 2 (=28) 67 – 56 (=11) **or** 67 – 2×"28" (=11) **or** 123 – 4×"28" (=11) (67 – 2×"11") × (123 – 2×"11") **(**45 × 101) **or** 123 × 67 – 12 × "28" ×" 11" (8241 – 3696)	4545	5	M1 M1 for method to find length or width M1 for method to find other dimension M1 dep on M2 A1

8	28 × 5 (= 140) **OR** 26.5 × 2 (= 53)			M1	or 87
	(28 × 5 − 26.5 × 2) ÷ (5 – 2)			M1	for a complete method
		29	3	A1	
					Total 3 marks

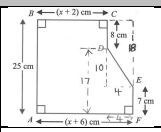
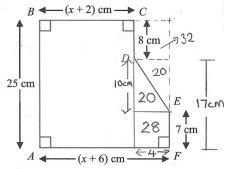
9	1.5 × 2 × 8 (= 24 (cm^3))			M1	for finding the volume of the cuboid
	e.g. $(V =) \frac{5.73\times1000}{19.32}$ (= 296.58...) **or** (*M* =) 19.32 × "24" (= 463.68)			M2	complete method to find the volume of statue **or** the mass of one block, could work in g or kg (if not M2 then award M1 for correct use of density formula e.g. $19.32 = \frac{5.73\times1000}{V}$ **or** $19.32 = \frac{M}{"24"}$)
	e.g. "296.58" ÷ "24" (= 12.3576...) **or** "5730" ÷ "463.68" (= 12.3576...)			M1	could work in g or kg
		13	5	A1	cao
					Total 5 marks

10	e.g. 6(*x* – 1) (= 6*x* – 6)			M1	method to find expression for perimeter of hexagon
	e.g. 2(*x* + 5) + 2*x* – 3 (= 4*x* + 7)			M1	method to find expression for perimeter of triangle
	"6*x* – 6" = "4*x* + 7"			M1	(dep on at least M1) for equating both expressions
	e.g. 6*x* – 4*x* = 7 + 6			M1	(dep on previous M1 and equation of the form $ax + b = cx + d$) for rearranging the *x* terms on one side and the numerical terms on the other and all expansions correct.
		5.5	5	A1	oe (dep on M2)
					Total 5 marks

10	$7^2-(10\div 2)^2\ (=24)$ or $\frac{\sin\left(\frac{1}{2}x\right)}{5}=\frac{\sin 90}{7}$ oe or $\cos x=\frac{7^2+7^2-10^2}{2\times 7\times 7}$ oe or $\sin\left(\frac{1}{2}x\right)=\frac{5}{7}$ oe or $\cos y=\frac{5}{7}$ oe		5	M1 or use of sine rule or cosine rule to find angle (x) of the apex or angle y $\left(=90-\frac{1}{2}x\right)$
	$\sqrt{7^2-(10\div 2)^2}$ $(=\sqrt{24}=2\sqrt{6}=4.898...)$ or $(x=)2\times\sin^{-1}\left(\frac{5\times\sin 90}{7}\right)(=91.169\ldots)$ oe or $(x=)2\times\sin^{-1}\left(\frac{5}{7}\right)(=91.169\ldots)$ oe or $(x=)\cos^{-1}\left(\frac{7^2+7^2-10^2}{2\times 7\times 7}\right)(=91.169\ldots)$ oe or $(x=)2\left(90-\cos^{-1}\left(\frac{5}{7}\right)\right)(=2(90-44.415)...=91.169...)$ Allow 5 from correct working			M1 for complete method to find height of triangle or the angle (x) of the apex $\cos^{-1}\left(\frac{5}{7}\right)(=44.415...)$ **and** $5\times\tan'44.415...'(=4.898...)$ or $7\times\sin'44.415...'(=4.898...)$ **or** $\sin^{-1}\left(\frac{5}{7}\right)(=45.584...)$ **and** $\frac{5}{\tan'45.584...'}(=4.898...)$ or $7\times\cos'45.584...'(=4.898...)$
	E.g. $6\times 10+\frac{(10\div 2)\times'\sqrt{24}'}{2}\times 2$ $(=60+10\sqrt{6}=84.494...)$ **or** $5\times\left(6+6+'\sqrt{24}'\right)(=60+10\sqrt{6}=84.494...)$ **or** $\left(\frac{1}{2}\times 7\times 7\times\sin'91.169...'+10\times 6\right)(=60+10\sqrt{6}=84.494...)$			M1 for method to find the total area of the pentagon allow answers in the range 84.49 – 85
	E.g. '84.494' ÷ 16 (= 5.28...) or $\left(60+10\sqrt{6}\right)\div 16(=5.28...)$			M1 for method to find the number of tins required using their area
		6		A1 dep on at least M2
				Total 5 marks

3	(a)	$54 \div 9 \times 4$ oe or $\frac{4}{9} \times 54$ oe		2	M1 Allow $0.44(44\ldots) \times 54$ or $\frac{24}{54}$
		Correct answer scores full marks (unless from obvious incorrect working	24		A1
	(b)	$\frac{"24"+n}{54+n} = \frac{1}{2}$ or $\frac{30}{60}$ or 54 – "24" (= 30) and "30" – "24" or 2 × "30" – 54		2	M1 ft if "24" < 27 or $\frac{6}{60}$
		Correct answer scores full marks (unless from obvious incorrect working)	6		A1
					Total 4 marks

4	2×0.75 (= 1.5) oe or $2 \times 0.75 \times 2$ (= 3) oe		5	M1 for area of rectangle
	$\pi \times (0.5 \div 2)^2$ (= 0.1963) or $\frac{1}{2} \times \pi \times (0.5 \div 2)^2$ (= 0.09817)			M1 for area of circle **or** area of semicircle
	"1.5" – "0.09817" (= 1.4018…) or "3" – "0.1963" (= 2.8036…)			M1
	"1.4018" × 2 × 250 ÷ 4 (= 175.228…) or "2.8036" × 250 ÷ 4 (= 175.228…) or "1.4018" × 250 ÷ 4 (= 87.6…)			M1or for 87 – 88
	Correct answer scores full marks (unless from obvious incorrect working)	175		A1 Allow 175 – 176
				Total 5 marks

Q	Working	An	Mark	Notes
10	 4 from F to left, vertically below D 17 from D vertically down to left of F 10 from D vertically to left of E 18 vertically up from E to right of C		5	B1 for a length of 4 (cm) or 17 (cm) or 25 – 7 – 8 (=10 (cm)) or 18 (cm) in the correct place on the diagram or calculated or used correctly in working.
	eg $25(x+2)(=25x+50)$ **or** $\frac{7+(25-8)}{2}\times((x+6)-(x+2))(=48)$ **or** $25(x+6)(=25x+150)$ **or** $\left(\frac{8+(25-7)}{2}\times 4\right)(=52)$ **or** $8(x+2)(=8x+16)$ **or** $\frac{(x+2)+(x+6)}{2}\times(25-8-7)(=10x+40)$ **or** $7(x+2)(=7x+14)$ **or** $10(x+2)(=10x+20)$ or $7(x+6)(=7x+42)$ **or** $(25-7)\times(x+2)(=18x+36)$ **or** $0.5(25-8-7)\times 4(=20)$			M2 for 2 correct expressions or values for the area of any 2 parts of the shape that do not overlap (unless subtracting) (need not be added or subtracted) (figures to be correct or come from correct working to award marks) **(M1 for one correct expression)** 
	eg $25x + 98 = 258$ or $25(x + 2) + 4 \times 7 + 0.5 \times 4 \times 10 = 258$ oe or $25(x + 6) = 258 + 20 + 32$ oe **or** a fully correct numerical method eg $(258 - 98) \div 25$ oe			M1 for an equation that is correct or from correct working. This need not have expanded terms and may not equal 258 if other work has been done. All parts for their method must be included with no overlaps OR a complete numerical method
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	6.4		A1 oe eg $160/25$
				Total 5 marks

10	$23 \times 4.7\ (= 108.1)$ oe			5	B1	(indep) May be embedded in $23 \times (4.7 + 2.5)$ $(= 165.6)$
	$\sin 30 = \frac{(x)}{5}$ or $\frac{(x)}{\sin 30} = \frac{5}{\sin 90}$ oe where x = height of trapezium	$5\cos 30 \left(= \frac{5\sqrt{3}}{2} = 4.33...\right)$ **and** $(x^2 =) 5^2 - "5\cos 30"^2 (= 6.25)$			M1	
	$(x =) 5\sin 30 (= 2.5)$ oe or $(x =) \frac{5}{\sin 90} \times \sin 30 (= 2.5)$ oe	$(x =) \sqrt{5^2 - "5\cos 30"^2} (= 2.5)$			M1	
	$\frac{1}{2} \times (11 + 23) \times "2.5" (= 42.5)$ oe or $\left(\frac{1}{2} \times "2.5" \times (23 - 11)\right) + (11 \times "2.5") (= 42.5)$ oe or $\left(\frac{1}{2} \times "2.5" \times (23 - 11 - "4.3")\right) + (11 \times "2.5") + \left(\frac{1}{2} \times "2.5" \times "4.3"\right) (= 42.5)$ oe or $(11 \times "2.5") + \left(\frac{1}{2} \times 5 \times (23 - 11) \times \sin 30\right) (= 42.5)$ oe or $(23 \times "2.5") - \left(\frac{1}{2} \times "2.5" \times (23 - 11 - "4.3")\right) - \left(\frac{1}{2} \times "2.5" \times "4.3"\right) (= 42.5)$ oe or $(23 \times ("2.5" + 4.7)) - \left(\frac{1}{2} \times "2.5" \times (23 - 11 - "4.3")\right) - \left(\frac{1}{2} \times "2.5" \times "4.3"\right)$ oe				M1	for a correct method to find the area of the trapezium or the whole shape
	Working required		150.6		A1	dep on M1 awrt 150.6 Allow 151 Accept $\frac{753}{5}$
						Total 5 marks

25	eg $\tan 30 = \frac{x}{0.5AB}$ **or** $\tan 60 = \frac{0.5AB}{x}$ oe **or** $0.5AB = \frac{x}{\tan 30}$ **or** $0.5AB = x\tan 60$ oe **or** $\frac{1}{2}AB = \sqrt{3}x$		5	M1 (off spec but a student who knows without calc that height of triangle = $3x$: $\tan 60 = \frac{3x}{0.5AB}$ or $\sin 60 = \frac{3x}{BC}$)
	eg ($AB =$) $2x\tan 60$ **or** $\frac{2x}{\tan 30}$ **or** $2\sqrt{3}x$ **or** $3.46..x$ oe **OR** area small⌴ $\left(\frac{1}{6}\text{shape}\right) = \frac{1}{2}\times x\tan 60\times x$ **or** $\frac{1}{2}\times\sqrt{3}x\times x$ **or** $\frac{\sqrt{3}}{2}x^2$			M1 Expression for side of triangle (*AB* or *BC* or *AC*) **OR** the area of one or more of the six triangles
	eg $6\times\frac{1}{2}\times x\tan 60\times x$ **or** $\frac{1}{2}\times(2x\tan 60)^2\times\sin 60$ **or** $\frac{1}{2}\left(\frac{2x}{\tan 30}\right)^2\sin 60$ **or** $\frac{1}{2}\times 2\sqrt{3}x\times\sqrt{\left(2\sqrt{3}x\right)^2-\left(\sqrt{3}x\right)^2}$ **or** $0.5\times 2\sqrt{3}x\times 3x$ **or** $3\sqrt{3}x^2$ **or** $5.19...x^2$			M1 a correct expression for the area of triangle *ABC*
	$6\times\frac{\sqrt{3}}{2}x^2-\pi x^2$ **or** $3\sqrt{3}x^2-\pi x^2$ **or** "5.19..." $x^2-\pi x^2$ **or** $6\times\frac{1}{2}\times\tan 60\times x^2-\pi x^2$ **or** $\frac{1}{2}\left(\frac{2x}{\tan 30}\right)^2\sin 60-\pi x^2$ oe			M1 a correct expression for the area of the shaded parts of the diagram or a correct equation for the shaded parts of the diagram
	Correct answer scores full marks (unless from obvious incorrect working) **Look for values written on the diagram**	2.05		A1 2.05 – 2.06
	SEE NEXT PAGE FOR USING A VALUE FOR RADIUS			**Total 5 marks**

25	eg $\tan 30 = \frac{100}{0.5AB}$ **or** $\tan 60 = \frac{0.5AB}{100}$ oe **or** $0.5AB = \frac{100}{\tan 30}$ **or** $0.5AB = 100\tan 60$ oe **or** $\frac{1}{2}AB = \sqrt{3}\times 100$		5	M1 eg using radius = **100** **ANY VALUE CAN BE USED CONSISTENTLY FOR AWARD OF MARKS**
	eg $(AB =)\ 200\tan 60$ **or** $\frac{200}{\tan 30}$ **or** $200\sqrt{3}x$ or $346\ldots x$) or area small triangle$\left(\frac{1}{6}shape\right)$ = $\frac{1}{2}\times$"173..."×100 (= 8660…)			M1 Expression for side of triangle or the area of one or more of the six triangles
	eg $\frac{1}{2}\times 200\sqrt{3}\times 200\sqrt{3}\times\sin 60 (= 51961.52...)$ or or $6\times\frac{1}{2}\times$"173..."×100 $(= 6\times$"8660..." $= 51961.52...)$			M1 a correct expression for the area of the triangle
	eg "51961.52" $-\pi\times 100^2 = 100^2 n$			M1 a correct equation for the area of the shaded parts of the diagram.
	Correct answer scores full marks (unless from obvious incorrect working)	2.05		A1 2.05 – 2.06
	SEE PREVIOUS PAGE FOR USING *x* FOR RADIUS			**Total 5 marks**

9	eg $12\sin 60\left(=6\sqrt{3}=10.3(9...)\right)$ **or** $\sqrt{12^2-"6"^2}\left(=6\sqrt{3}=10.3(9...)\right)$ **or** (Area *ADC* =) $\frac{1}{2}\times 12\times 47\times\sin 60 (=244.2...)$		5	M1 for a method find the height of the trapezium **or** the area of triangle *ADC* The first two M1 marks can be awarded in either order
	eg $12\cos 60(=6)$ **or** $\sqrt{12^2-\left("6\sqrt{3}"\right)^2}\ (=6)$			M1 (indep) for a method find the base of the triangle, condone missing brackets around $"6\sqrt{3}"$ The first two M1 marks can be awarded in either order
	eg (*AB* =) 47 – "6" – "6" (= 35)			M1 (dep on previous M1) for method to find the length of *AB*
	eg (Trapezium =) $\frac{1}{2}\times(47+"35")\times"10.3(9...)"$ **or** (Rectangle + 2 × Triangle =) $"35"\times"10.3(9...)"+2\times\frac{1}{2}\times"6"\times"10.3(9...)"$ **or** (Rectangle + 2 × Triangle =) $"35"\times"10.3(9...)"+2\times\frac{1}{2}\times"6"\times 12\times\sin 60$ **or** (Triangle *ADC* + Triangle *ABC* =) $"244.2..."+\frac{1}{2}\times 12\times"35"\times\sin 120$ oe eg $(47-"6")\times"10.3(9...)"$			M1 for a complete method There are other methods and marks should be awarded for a complete method that should give the correct area
	Working required	426		A1 (dep on M1) allow 420 – 427 from correct working
				Total 5 marks

4		45 ÷ 1.5 (= 30) **or** 5 × 12 (= 60) **or** $\frac{64}{1.5}\left(=\frac{128}{3}=42.6(6...)\right)$		5	M1 for a method to find the number of boxes needed **or** the cost of adhesive **or** cost of tiles per m^2
		"30" × 64 (= 1920) **or** "42.6(6…)" × 45 (=1920)			M1 for a method to find the cost of the boxes of tiles
		"1920" + "60" (= 1980) **or** 3000 – 1920 – 60 (=1020)			M1 for a method to find the total cost **or** the profit
		eg $\frac{3000-"1980"}{"1980"}$ (= 0.515...) **or** $\frac{3000-"1980"}{"1980"}\times 100$ **or** $\frac{3000}{"1980"}$ (= 1.515…) **or** $\frac{3000}{"1980"}$ ´ 100 (= 151.5…) **or** $\frac{3000}{"1980"}\times 100-100$			M1 for a method to find the percentage profit or be one step away
		Correct answer scores full marks (unless from obvious incorrect working)	51.5		A1 awrt 51.5 SCB3 for answer 56.3 or 56.25 (from use of 1920 instead of 1980 as total cost)
					Total 5 marks

Question		Working	Answer	Mark	Notes
15	(a)	e.g. $\frac{1}{2}\times(x+5+3x-2)\times(2x-3)$ or $0.5(4x + 3)(2x – 3)$ oe			M1 correct algebraic expression for area
		eg. $\frac{1}{2}\times(8x^2-12x+6x-9)=133$ or $8x^2 – 12x + 6x – 9 = 266$			M1 for correct equation with brackets expanded
			shown	3	A1 for completion to given equation dep on M2
	(b)	$\frac{--6\pm\sqrt{36--8800}}{2\times8}$ **or** $\frac{6\pm\sqrt{36+8800}}{16}$ **or** $\frac{6\pm\sqrt{8836}}{16}$ **or** $(4x – 25)(2x + 11)$ (=0)			M2 If not M2 then award M1 for $\frac{--6\pm\sqrt{(-6)^2-4\times8\times-275}}{2\times8}$ Condone one sign error in substitution; allow evaluation of individual terms e.g. 36 in place of $(−6)^2$ [allow $−6^2$ or 6^2 in place of $(−6)^2$, throughout allow + rather than ±] **or** $(4x \pm 25)(2x \pm 11)$ (=0) (if student gains M1 and shows both answers the 2nd M1 can be awarded) ft from an incorrect 3 term quadratic equation
			6.25 oe	3	A1 dep on M1 **and** 6.25 oe alone given as final answer

22	Ext angle of octagon = 360 ÷ 8 (= 45) **or** Int angle of octagon (8 – 2) × 180 ÷ 8 oe (= 135)		6	M1	for method to find the size of one exterior **or** one interior angle of a regular octagon
	e.g. 10 + 2 × 10 × sin45 (= $10+10\sqrt{2}$ or 24.1...) **or** e.g. $\frac{10\sin 112.5}{\sin 22.5}$ (= 24.1…)			M1	method to find *HE* **or** *AD* 22.5 comes from (180 – "135") ÷ 2 112.5 comes from "135" – "22.5"
	e.g. 10 × ("$10+10\sqrt{2}$") (= 100 + $100\sqrt{2}$ or 241.4...) **or** 10 × "24.1…" (= 241.4…)			M1	area *ADEH*
	e.g. 10 × sin45° (=5 $\sqrt{2}$ or 7.07...) **or** e.g. $\sqrt{10^2+10^2-2\times10\times10\times\cos"135"}$ (= 18.4…) **or** $\frac{10\sin"135"}{\sin 22.5}$ (= 18.4…)			M1	finds perpendicular height of triangle *ACD* (may be found before, but must realise this is also height of triangle) **or** finds the length of *AC* 22.5 comes from (180 – "135") ÷ 2
	e.g. 0.5 × "24.1..." × "7.07…" (= 85.3...) **or** $0.5\times10\times"18.4..."\times\sin112.5$ (= 85.3…)			M1	finds the area of triangle *ACD* 112.5 comes from "135" – "22.5"
		327		A1	accept 326 – 327
	Alternative (splitting octagon into triangles and subtracting trapezium and triangle)				
	Ext angle of octagon = 360 ÷ 8 (= 45) **or** Int angle of octagon (8 – 2) × 180 ÷ 8 oe (= 135) **or** one of 8 angles at centre = 360 ÷ 8 (= 45)		6	M1	for method to find the size of one exterior **or** one interior angle of a regular octagon **or** method to find one angle at centre of octagon when split into 8 equal triangles
	e.g. 0.5 × 10 × 5 × tan67.5 (= 60.35...) **or** $0.5\times\left(\frac{10\sin 67.5}{\sin 45}\right)^2\times\sin 45$ (= 60.35...) **or** Octagon = 8 × "60.35" (= 482.8...)			M1	Area of one triangle (one-eighth of octagon) **or** octagon
	e.g. 10 + 2 × 10×sin45°(= $10+10\sqrt{2}$ =24.14..)			M1	Method to find *HE*
	0.5 × (10 + $10+10\sqrt{2}$)×$5\sqrt{2}$ (=120.71...)			M1	Method to find area of trapezium *HEGF*
	0.5 × 10 × 10 × sin135°(= 35.35...)			M1	Method to find area of triangle *ABC*
		327		A1	accept 326 – 327
					Total 6 marks

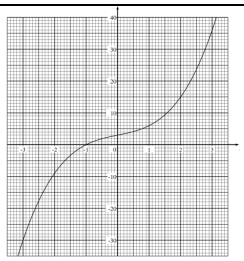
19 (a)	E.g. $x+y+x+y+x=100$ oe or $3x + 2y = 100$ oe $\left(y=\frac{100-3x}{2}\right)$			3	M1 for a correct equation for the perimeter of the shape **or** for a correct expression for the area of triangle *CED*
	E.g. $\frac{1}{2}\times x\times x\times\sin 60$ $\left(=\frac{1}{2}\times x\times x\times\frac{\sqrt{3}}{2}\right)$ $\left(=\frac{x^2\sqrt{3}}{4}\right)$	E.g. $x^2=\left(\frac{x}{2}\right)^2+h^2$ **and** $=\frac{1}{2}\times x\times\frac{x\sqrt{3}}{2}\left(=\frac{x^2\sqrt{3}}{4}\right)$			
	$x"\left(\frac{100-3x}{2}\right)"+"\frac{x^2\sqrt{3}}{4}"$ oe				M1 for the area of the shape in terms of x only
	E.g. $x\left(\frac{200-6x}{4}\right)+\frac{x^2\sqrt{3}}{4}$ or $\frac{x}{4}(200-6x+x\sqrt{3})$ or $\frac{200x-6x^2}{4}+\frac{x^2\sqrt{3}}{4}$ or $\frac{x}{4}(200x-6x^2+x^2\sqrt{3})$		Shown		A1 for the area given in correct form with full working shown (at least one intermediate step before the answer)
(b) (i)	$\left(\frac{dR}{dx}=\right)50-\frac{3}{2}\times 2\times x+2\times\frac{x\sqrt{3}}{4}=0$ oe			2	M1 for differentiation of correct expression with 2 out of 3 terms correct and equated to 0 (can be implied by subsequent working)
	Correct answer scores full marks (unless from obvious incorrect working)		$\frac{100}{6-\sqrt{3}}$		A1 for a correct expression
(ii)			Correct reason	1	B1 for correct reason R is a quadratic with negative coefficient of x^2 E.g. the graph of R is ∩ shaped or (allow $\frac{d^2R}{dx^2}<0$ oe)
					Total 6 marks

11	(a)	$2^{\frac{1}{2}} \times 2^4$ **or** eg $2 \times (2^4)^2 = (2^x)^2$ or $2^9 = 2^{2x}$		2	M1	for a correct expression in powers of 2 that is equivalent to 2^x eg $2^{\frac{1}{2}} \times 2^4$ **or** for showing $\sqrt{2} = 2^{\frac{1}{2}}$ **and** $16 = 2^4$ **or** for writing the equation in powers of 2 eg $2 \times (2^4)^2 = (2^x)^2$ or $2^9 = 2^{2x}$
		Working required	$\frac{9}{2}$		A1	**or** 4.5 **or** 4½ dependent on M1
	(b)	$\frac{11^{-30}}{11^4}$ **or** $-30 - 4 = n$ **or** $-30 = n + 4$ oe		2	M1	For $(11^{-6})^5$ written as 11^{-30} in the equation or $(11^{-6})^5 = 11^{-30}$ shown in working **or** a correct equation with indices only (no marks for $3.914....\times 10^{-36}$)
		Working required	−34		A1	dep on M1 (as we have asked for working)
						Total 4 marks

12		$\frac{50}{360} \times \pi \times 7 \times 2$ oe eg $\frac{14\pi}{36} \times 5$ **or** "43.98…"÷ 360 × 50 oe		2	M1	Students may use π or 3.14, 3.142 or $\frac{22}{7}$
		Working not required, so correct answer scores full marks (unless from obvious incorrect working)	6.1		A1	Accept answers in the range 6.05 – 6.2
						Total 2 marks

10	3 × 2.5 (= 7.5) oe or 2 × 3 × 2.5 (= 15) oe or 12 × 3 (= 36) oe or 2 × 12 × 3 (= 72) oe or 12 × 2.5 (= 30)		6	M1 for area of rectangle
	(2 × 3 × 2.5) + (2 × 12 × 3) + (12 × 2.5) (= 117) or (2 × 7.5) + (2 × 36) + (12 × 2.5) (= 117) or 15 + 72 + 30 (= 117)			M1 for a complete method to find the surface area
	1 + 0.1 (= 1.1) **or** 100(%) + 10(%) (= 110(%)) **or** $\frac{26.95}{110}$ (= 0.245) oe			M1
	26.95 ÷ "1.1" (= 24.5(0)) **or** 26.95 ÷ "110" × 100 (= 24.5(0)) **or** 26.95 × 100 ÷ "110" (= 24.5(0)) oe **or** "0.245" × 100 (= 24.5(0)) oe			M1 dep on previous M1
	"117" ÷ 15 (= 7.8 or 8) **and** "8" × "24.50" (= 196) **or** "117" ÷ 15 (= 7.8 or 8) **and** 200 ÷ "24.5" (= 8.1...) **or** "117" ÷ 15 (= 7.8 or 8) **and** 200 ÷ "8" (= 25)			M1for working with a whole number of tins (rounded up) to reach figures where a decision can be made
		Correct figures to show that Jonty is correct		A1 e.g. 196 7.8 or 8 **and** 8.1... 24.5 **and** 25
				Total 6 marks

11	$\frac{110}{360}\times\pi\times7.1^2$ oe or $\frac{110}{360}\times3.14....\times7.1^2$ oe		2	M1 for a complete method to find the area
		48.4		A1 accept 48.3 – 49.2
				Total 2 marks

10	(a)		−30, 15	1	B1	for −30 and 15 in the correct place, this may be awarded if plotted correctly on the graph
	(b)			2	M1ft	for at least 6 points plotted correctly (within the circles on the overlay) ft their incorrect table
		 *Correct answer scores full marks (unless from obvious incorrect working)*	Correct graph		A1	for correct curve between $x = -3$ and $x = 3$ (clear intention to go through all the points and which must be curved) Ignore to the left of $x = -3$ and to the right of $x = 3$ **Note**: If a fully correct graph is shown, but a blank table is shown in (a), then award the mark for (a)
						Total 3 marks

11	eg $\pi \times 16^2 \times \frac{140}{360}$ oe eg $256\pi \times \frac{7}{18}$		2	M1 allow use of 3.14… or $\frac{22}{7}$ for π $\frac{140}{360}$ may be seen as an equivalent fraction or decimal eg $\frac{7}{18}$ or $0.3\dot{8}$ 0.388(8…) or 0.389
	Correct answer scores full marks (unless from obvious incorrect working)	313		A1 accept 311.8 – 313
				Total 2 marks

Question	Working	Answer	Mark	Notes
10	$\pi\times\left(\frac{12}{2}\right)^2$ (=113….) or $\pi\times\left(\frac{12}{2}-2\right)^2$ (= 50.2…) or $\pi\times\left(\frac{12}{2}\right)^2\div 2$ (=56.5...) or $\pi\times\left(\frac{12}{2}-2\right)^2\div 2$ (= 25.1…)	10π	3	M1
	eg $(\pi\times 6^2-\pi\times 4^2)\div 2$ oe			M1 for a complete method
				A1

5	$\pi \times 7.2^2 \div 2$ (= 81.4....)			M1	allow 81.3 – 81.5 for area of semi circle
	"81.4" ÷ 6 (= 13.5...) **or** 12 × 6 (= 72) **or** "81.4" ÷ 12 (= 6.7...)			M1	(dep) allow 13.5 – 13.6 for the number of boxes needed (NB: 12 × 6 = 72 alone is 0 marks)
		No with correct figures	3	A1	
					Total 3 marks

6	$(x \pm 9)(x \pm 4)$	$\frac{-(-5) \pm \sqrt{(-5)^2 - 4 \times 1 \times (-36)}}{2 \times 1}$ **or** $\frac{5 \pm \sqrt{25 + 144}}{2}$			M1	**or** $(x + a)(x + b)$ where $ab = -36$ **or** $a + b = -5$ **OR** correct substitution into quadratic formula (condone one sign error in a, b or c) (if + rather than ± shown then award M1 only unless recovered with answers)
	$(x - 9)(x + 4)$	$\frac{5 \pm \sqrt{169}}{2}$ **or** $\frac{5 \pm 13}{2}$			M1	**or** $\frac{5 \pm \sqrt{169}}{2}$ **or** $\frac{5 \pm 13}{2}$
			9, −4	3	A1	dep on at least M1
						Total 3 marks

7	20.40 ÷ (1 – 0.15)			M2	for a complete method eg 20.40 ÷ (1 – 0.15) for 20.40 ÷ (100 – 15) (= 0.24)
				(M1)	**or** e.g. $0.85x = 20.40$
		24	3	A1	
					Total 3 marks

8	$2 \times \pi \times 7$ (= 43.982… or 14π) **or** $(2 \times \pi \times 7) \div 2$ (= 21.991… or 7π) **or** $2 \times \pi \times 9$ (= 56.548… or 18π) **or** $(2 \times \pi \times 9) \div 2$ (= 28.274… or 9π)		3	M1	for finding the circumference of either the full circle or the length of the arc for either semicircle
	e.g. "21.991" + "28.274" (= 50.26…) **or** "7π" + "9π" (=16π) **or** "21.991" + "28.274" + 2 (= 52.26…) **or** "7π" + "9π" + 2 (= 52.26…) **or** "21.991" + "28.274" + 2 + 2 **or** "7π" + "9π" + 2 + 2			M1	for a method to find the length of the two arcs with intention to add
		54.3		A1	accept 54.2 – 54.3
					Total 3 marks

9	(a)		$16x^{12}y^{20}$	2	B2	B1 for an answer in the form ax^ny^m with 2 correct from $a = 16$, $n = 12$, $m = 20$
	(b)(i)	$(x \pm 9)(x \pm 4)$		2	M1	for $(x \pm 9)(x \pm 4)$ **or** for $(x + a)(x + b)$ where $ab = -36$ or $a + b = 5$
			$(x + 9)(x - 4)$		A1	
	(ii)		–9, 4	1	B1	ft from (b)(i)
						Total 5 marks

International GCSE Maths					
Apart from Q9, 10, 12, 17b, 18, 19a & 21 (where the mark scheme states otherwise) the correct answer, unless obtained from an incorrect method, should be taken to imply a correct method.					
Q	**Working**	**Answer**	**Mark**	**Notes**	
1 (a)	$5 \times (-2)^2 - (-2)^3$ (= 20 – –8)		2	M1	for correct expression or at least one of 20 or 5×4 or – – 8 or (+) 8
		28		A1	
(b)		$2p(4p - 1)$	2	B2	B1 for $p(8p - 2)$ or $2(4p^2 - p)$ or $2p(4p - 1)$ with two terms inside the bracket with one term correct.
(c)		$12t^2 - 8t$	2	B2	B1 for $12t^2$ or $-8t$
(d)	$5x^2 + 20x - 2x - 8$		2	M1	for 4 correct terms (ignoring signs) or 3 correct terms with correct signs. or $5x^2 + 18x + ...$ or … + 18x − 8
		$5x^2 + 18x - 8$		A1	
					Total 8 marks

2	$0.5 \times \pi \times 6^2$ (= 56.54…) **or** 12×6 (= 72) **or** $\pi \times 6^2$ oe		3	M1	
	"72" – "56.54…"			M1	dep M1 for a complete method
		15.5		A1	15.4 to 15.5
					Total 3 marks

12	eg $6 \div 1.2\ (=5)$ **or** $1.2 \div 6\ (=\frac{1}{5})$ or $\frac{2x}{1.2}=\frac{2x+9}{6}$ oe or $\frac{2x}{2x+9}=\frac{1.2}{6}$ oe		3	M1	for finding the scale factor or using a correct ratio or fraction method
	eg "5" × $2x = 2x + 9$ **or** $2x\times6=1.2(2x+9)$ oe eg $12x=2.4x+10.8$ or $9.6x = 10.8$ oe			M1	for setting up an equation in x and removing denominators
		$\frac{9}{8}$		A1	oe eg 1.125 (allow 1.12 or 1.13)
					Total 3 marks

13	eg $2\times\pi\times5.2\ (=32.6...\text{or}\ \frac{52}{5}\pi)$ oe $\frac{67}{360}\times2\times\pi\times5.2(=6.08...\text{or}\ \frac{871}{450}\pi)$ oe		3	M1	for finding the whole circumference or the arc length
	$\frac{67}{360}\times2\times\pi\times5.2 + 2\times5.2$ oe			M1	for a complete method
		16.5		A1	accept 16.4 - 16.5 (not in terms of π)
					Total 3 marks

14	$(\angle AOC =)132\times 2(=264)$		3	M1 for method to find angle at the centre. Do not award this mark if contradicted on the diagram eg if obtuse *AOC* is labelled as 264
	eg $\frac{"264"}{360}\times 2\times\pi\times 8.5$ $(=39.1...$ or $\frac{187}{15}\pi)$ **or** $2\times\pi\times 8.5-\frac{360-"264"}{360}\times 2\times\pi\times 8.5$ $(=39.1...$ or $\frac{187}{15}\pi)$ **or** $\frac{"264"}{360}\times 2\times\pi\times 8.5+2\times 8.5$ **or** $2\times\pi\times 8.5-\frac{360-"264"}{360}\times 2\times\pi\times 8.5+2\times 8.5$			M1 for a method to find the length of arc *AC* or perimeter of the sector – allow use of their *AOC* as long as clearly labelled
	Correct answer scores full marks (unless from obvious incorrect working)	56.2		A1 accept 56.1 – 56.2
				Total 3 marks

5	$\pi \times 20 (= 20\pi = 62.8(31...))$ oe or $2 \times \pi \times (20 \div 2) (= 20\pi = 62.8(31...))$ oe or $0.5 \times \pi \times 20 (= 10\pi = 31.4(15...))$ oe or		3	M1 for use of $\frac{1}{2}\pi d$ or $_{\pi r}$ or πd or $2\pi r$ oe with $d = 20$ or $r = 20 \div 2$ (= 10)
	3 × ("62.8" ÷ 2) + 20 ÷ 2 + 20 ÷ 2 oe or 1.5 × ("62.8") + 20 ÷ 2 + 20 ÷ 2 oe			M1 for a complete method
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	114		A1 114 – 115 SCB1 for awrt 471
				Total 3 marks

13	$\frac{60}{360}\times 2\times\pi\times r$ oe or $\frac{1}{6}\times 2\times\pi\times r$ oe		3	M1 for finding the length of the arc
	"$\frac{60}{360}\times 2\times\pi\times r$"$+2r$ oe or "$\frac{1}{6}\times 2\times\pi\times r$"$+2r$ oe			M1 dep on M1 for a complete expression from correct working for a method for the perimeter
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	$P=r\left(\frac{1}{3}\pi+2\right)$		A1 oe eg $P=r(0.33...\pi+2)$ or $P=\left(\frac{1}{3}\pi+2\right)r$ or $P=\left(2+\frac{120}{360}\pi\right)r$ or $P=\left(\frac{120}{360}\pi+2\right)r$
				Total 3 marks

14	0.24 ÷ 0.8 (= 0.3) oe		3	M1
	"0.3" × (1 – 0.8) oe or "0.3" × 0.2 oe or 1 – ("0.3" × 0.8 + 0.7 × 0.8 + 0.7 × 0.2) oe or 1 – 0.94 oe			M1 for a complete method
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	0.06		A1 oe eg $\frac{3}{50}$ or $\frac{6}{100}$ or 6%
				Total 3 marks

Question	Working	Answer	Mark	Notes
5 a		80 000	1	B1
b	$0.5 \times 10^{5-8}$ **or** 0.0005 **or** 5×10^{n} **or** 5.0×10^{n}	5×10^{-4}	2	M1 A1 for 5×10^{-4} or 5.0×10^{-4} SC : B1 for $\frac{1}{2000}$ **or** $\frac{1}{2\times10^{3}}$
6	$9.7^2 + 3.5^2$ (=106.34) $\sqrt{9.7^2+3.5^2}$ or $\sqrt{\text{"106.34"}}$ (=10.3…) $\pi \times$ "10.3…" **or** $2 \times \pi \times \frac{\text{"10.3..."}}{2}$	32.4	4	M1 M1 for the use of *MN* and a correct angle (70.1… or 70.2, 19.8…) in a correct trig statement eg $\cos 70.2 = \frac{3.5}{MN}$ M1 M1 for a complete method to find *MN* eg $MN = \frac{3.5}{\cos 70.2}$ (=10.3…) M1 dep on M2 A1 for answer in range 32.3 – 32.41

19	$\pi \times 12^2 \times \frac{AOC}{360} (=100)$		4	M1	oe for setting up a correct expression for the area of the sector (or equation)
	$(AOC =) \frac{100 \times 360}{\pi \times 12^2} \left(= \frac{250}{\pi}\right)$			M1	for correctly rearranging for *AOC*
	(Angle *ABC* =) "79.57747" ÷ 2 (= 39.7887… or $\frac{125}{\pi}$)			M1	ft dep 1st M1 **and** '*x*' less than 360 for dividing their '*AOC*' by 2
		39.8		A1	for awrt 39.8 accept $\frac{125}{\pi}$
					Total 4 marks

20	(a)	$T = \frac{k}{m^2}$ or $Tm^2 = k$		3	M1	for a correct equation with a constant Do not allow constant = 1
		$30 \times 0.5^2 = k$ or $30 = \frac{k}{0.5^2}$ or $k = 7.5$ or $k = \frac{15}{2}$			M1	dep on M1 for correct substitution in a correct equation M2 for $k = 7.5$ or $k = \frac{15}{2}$
			$T = \frac{7.5}{m^2}$		A1	for $T = \frac{7.5}{m^2}$ or $T = \frac{15}{2m^2}$ SCB2 for $Tm^2 = 7.5$ or $Tm^2 = \frac{15}{2}$ or $m^2 = \frac{7.5}{T}$ or $m^2 = \frac{15}{2T}$
	(b)		750	1	B1	cao
						Total 4 marks

11	$360 - 40\ (= 320)$ or $\frac{320}{360}$ oe **or** $\frac{40}{360} \times 2\pi \times 9\ (= 6.28...)$		4	M1
	$\frac{"320"}{360} \times 2\pi \times 9\ (= 16\pi\ = 50.26...)$ **or** $2\pi \times 9$ – "6.28" (= 50.26)			M1
	"50.26" + 2 × 9			M1 complete method to find perimeter
		68.3		A1 68.2 to 68.3
				Total 4 marks

12	eg. $10x + 35y = 85$ $10x + 6y = -2$ with the operation of subtraction **or** $29y = 87$ **or** $6x + 21y = 51$ $35x + 21y = -7$ with the operation of subtraction **or** $29x = -58$ **or** eg $5\left(\frac{17-7y}{2}\right)+3y=-1$ **or** eg $5x+3\left(\frac{17-2x}{7}\right)=-1$		4	M1 for correct method to eliminate one variable – multiplying one or both equations so the coefficient of x or y is the same in both, with the correct operation to eliminate one variable (condone one arithmetic error) **or** isolating x or y in one equation and substituting into the other (condone one arithmetic error).
				M1 dep 1st M1 Substitute found value into one equation **or** correct method to eliminate second unknown.
		$x = -2$ $y = 3$		A1 dep 1st M1 A1
				Total 4 marks

15	eg $40=\frac{k}{1.5^2}$ **or** $k=90$ **or** $\frac{C^2}{1.5^2}=\frac{40}{1000}(=0.04)$ **or** $(C^2=)1.5^2\times\frac{40}{1000}(=0.09)$ **or** $\frac{1.5^2}{C^2}=\frac{1000}{40}(=25)$ **or** $(C^2=)1.5^2\div\frac{1000}{40}(=0.09)$		3	M1
	eg $(C=)\sqrt{\frac{"90"}{1000}}$ oe **or** $(C=)\sqrt{1.5^2\times"0.04"}$ **or** $(C=)\sqrt{1.5^2\div"25"}$ **or** $(C=)\sqrt{"0.09"}$			M1
		0.3		A1 oe, allow ±0.3 oe or −0.3 oe
				Total 3 marks

16	eg $\frac{55}{360}\times\pi\times d=5$ **or** $\frac{55}{360}\times\pi\times2\times r=5$ oe **OR** $\frac{360}{55}\times5(=32.7...)$ oe		4	M1 for a correct equation for the diameter **or** radius **OR** for a method to find the circumference of the circle
	eg $d=\frac{5\times360}{55\pi}(=10.4...)$ **or** $r=\frac{5\times360}{55\times2\times\pi}(=5.2...)$ **OR** $d=\frac{32.7...}{\pi}(=10.4...)$ **or** $r=\frac{32.7...}{2\times\pi}(=5.2...)$			M1 for a method to work out the diameter **or** radius
	(area =) eg $\pi\times\left(\frac{"10.4..."}{2}\right)^2$ **or** $\pi\times$ "5.2..."^{2}			M1
		85.2		A1 allow 84.9 – 85.4
				Total 4 marks

20	eg $2d \times 2d - 4 \times \pi \times (\frac{1}{2}d)^2 (= 40)$ oe or $4r \times 4r - 4 \times \pi \times r^2 (= 40)$ oe or $x^2 - 4\pi\left(\frac{1}{4}x\right)^2 (= 40)$ oe or $w^2 - \pi\left(\frac{1}{2}w\right)^2 (= 10)$ oe		4	M1	oe a **correct** expression or a correct equation for the shaded area (must be in one unknown only) where d = diameter r = radius x = side of large square w = side of square when shape divided into 4
	$d = \sqrt{\frac{40}{4-\pi}} (= 6.826...)$ or $2d = \sqrt{\frac{160}{4-\pi}} (= 13.652\ldots)$ oe $r = \sqrt{\frac{40}{16-4\pi}} (3.413...)$ or $4r = \sqrt{\frac{640}{16-4\pi}} (= 13.652...)$ oe $x = \sqrt{\frac{40}{1-0.25\pi}} (13.652\ldots)$ or $w = \sqrt{\frac{10}{1-0.25\pi}} (= 6.826\ldots)$oe			M1	oe a correct expression for d or $2d$ or r or $4r$ or x or w
	(perimeter =) 8 × "6.826…" (8 × diameter(or side of small square when divided)) or 16 × "3.413..." (16 × radius) oe or 4 × "13.652…"(4 × side of square)			M1ft	dep on first M1 For substituting values into a calculation for the perimeter use of **their** r, d, x, w
		54.6		A1	54.4 - 54.7
					Total 4 marks

5	$\sqrt{36}\,(=6)$ **or** 6 **or** 6×6		4	M1	for method to find the length of the square – may be seen in later working
	eg $\pi \times \left(\frac{\text{[their 6]}}{2}\right)^2 \div 2 (=14.1\ldots \text{ or } 4.5\pi \text{ or } \frac{9}{2}\pi)$ **or** $\pi \times \left(\frac{\text{[their 6]}}{2}\right)^2 (=28.2\ldots \text{ or } 9\pi)$			M1	for method to find the area of one semicircle **or** circle or the incorrect number of semicircles or circles provided correct area of circle formula is seen for [their 6] allow any value if there is a clear implication this is their side length of square.
	eg $4 \times$ "14.1" $(=56.5\ldots \text{ or } 18\pi)$ **or** $2 \times$ "28.2" $(=56.5\ldots \text{ or } 18\pi)$			M1	ft dep on previous M1 for a complete method to find the total area of the semicircles [if the pupil multiplies again and uses the incorrect number of circles or semicircles this mark is not awarded]
		92.5		A1	accept 92.4 – 92.6 (not in terms of π)
					Total 4 marks

Question	Working	Answer	Mark	Notes
20	$0.5\times10\times10\times\sin60 (=25\sqrt{3}=43.3...)$ oe or $0.5\times10\times\sqrt{10^2-5^2}$ $(=25\sqrt{3}=43.3...)$ oe or $0.5\times10\times5\times\tan60$ $(=25\sqrt{3}=43.3...)$ oe or $\sqrt{15(15-10)^3}$ $(=25\sqrt{3}=43.3...)$ oe		4	M1 For a correct method to find the area of the triangle – this list is not exhaustive – please credit any relevant method
	(radius =) $5\tan30$ $(=\frac{5\sqrt{3}}{3}=2.886....)$ oe eg $\frac{5}{\sin60}\times\sin30$ or $\sqrt{10^2-5^2}-\frac{5(\sin90)}{\sin60}$ [*BF – OB where O is centre*] or $6\left(\frac{1}{2}\times5\times r\right)=25\sqrt{3}\Rightarrow r=\frac{25\sqrt{3}}{15}\left(=\frac{5\sqrt{3}}{3}\right)$ oe or $r=\frac{\sqrt{10^2-5^2}}{3}$			M1 Indep – correct method to find radius – this list is not exhaustive – please credit any relevant method
	$\pi\times\left(\frac{5\sqrt{3}}{3}\right)^2$ or $\pi\times(2.886...)^2\left(=\frac{25}{3}\pi=26.17\ldots\right)$			A1 A **correct** value or expression for the area of the circle
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	17.1		A1 awrt 17.1
				Total 4 marks

20	eg $\pi r^2 \times \frac{60}{360} - \frac{1}{2} r^2 \sin 60$ oe or $\frac{\pi r^2}{6} - \frac{\sqrt{3}}{4} r^2$ oe		4	M1 for a correct expression for the area of the segment Expression may be embedded in an equation, eg $\pi r^2 \times \frac{60}{360} - \frac{1}{2} r^2 \sin 60 = 38$ or $\pi r^2 \times \frac{60}{360} = 38 + \frac{1}{2} r^2 \sin 60$ or $\pi r^2 \times \frac{60}{360} - 38 = \frac{1}{2} r^2 \sin 60$
	eg $\left(r^2 =\right) 38 \div \left(\frac{\pi}{6} - \frac{\sqrt{3}}{4}\right) \left(= 38 \div 0.09(058)\right)$ (= 419(.490…)) oe or $\left(r =\right) \sqrt{38 \div \left(\frac{\pi}{6} - \frac{\sqrt{3}}{4}\right)}$ (= 20.4(81…))oe			M1 dep on M1 for a **correct** expression for r^2 or r
	$\frac{\pi}{6} \times$"20.4(81...)"$\times 2$ (= 21.4(48…)) oe or			M1 for using the value of r to find arc length
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	41.9		A1 allow 41 - 42
				Total 4 marks

4	(a)(i)		1, 2, 3, 5, 6, 7	1	B1	in any order with no repeats
	(a)(ii)		4, 5, 7, 8, 9, 10	1	B1	in any order with no repeats
	(b)	eg 1. 2 (**or** 3 **or** 2 and 3) is in both sets oe 2. *A* and *B* have 2 (**or** 3 **or** 2 and 3) oe 3. 2 (**or** 3 **or** 2 and 3) is common oe 4. 2 (**or** 3 **or** 2 and 3) is in the intersection oe 5. $A \cap B = \{2,3\}$ oe or $A \cap B = \{2\}$ oe or $A \cap B = \{3\}$ oe 6. They share 2 (**or** 3 **or** 2 and 3)oe 7. As 2 and/or 3 are factors of 6 and also prime numbers oe Allow sector for set This is not an exhaustive list	2 (**or** 3 **or** 2 and 3) is a member of *A* and *B*	1	B1	for identifying the element 2 **or** 3 **or** 2 and 3 with a correct explanation to show they know the meaning of intersection and empty set If students mention a number that is common, it must be correct
	(c)		1, 5, 6, 7	2	B2 (B1	for 1, 5, 6, 7 for three correct values with no more than one incorrect or for four correct values with no more than one incorrect)
						Total 5 marks

16	$120 = \frac{1}{2} \times a \times b \times \sin 50$ oe or $\frac{120 \times 2}{\sin 50}$ oe or $120 = \frac{1}{2} \times 2x \sin 25 \times x \cos 25$ oe or $\frac{120 \times 2}{2 \times \sin 25 \times \cos 25}$ oe or 313(.2977494)		4	M1 for a **correct** equation for $a \times b$ or r^2 (allow any letters for a or b) or for a **correct** expression for $a \times b$ or r^2 or for 313(.2977494)
	$(radius =) \sqrt{\frac{120 \times 2}{\sin 50}}$ (= 17.7(0021891)) oe or $(radius =) \sqrt{\frac{120 \times 2}{2 \times \sin 25 \times \cos 25}}$ (= 17.7(0021891)) oe or $(radius =) \sqrt{313(.2977494)}$ (= 17.7(0021891))			M1 for a **correct** rearrangement to find the radius or for square rooting 313(.2977494) or for 17.7(0021891))
	(area of $OAPB$ =) $\pi \times$"17.7"$^2 \times \frac{50}{360}$ oe			M1
	Correct answer scores full marks (unless from obvious incorrect working)	137		A1 awrt 137
				Total 4 marks

9		0.5 × 6 × 6 (=18)		5	M1	For area of triangle, or may use $\frac{1}{2}\times 6\times 6\sqrt{2}\sin 45$ or $\frac{1}{2}\times 6\sqrt{2}\times 3\sqrt{2}$ oe
		$(d^2 =) 6^2 + 6^2$ (=72) or $\frac{AC}{(\sin 90)} = \frac{6}{\sin 45}$			M1	
		$\sqrt{6^2+6^2}$ $(=\sqrt{72} = 6\sqrt{2}$ =8.4(85...)or 8.5) **or** $AC = \frac{6(\sin 90)}{\sin 45} = 6\sqrt{2}$ =8.4(85...)or 8.5) oe			M1	
		$0.5 \times \pi \times \left(\frac{"8.48.."}{2}\right)^2$ (= 9π or 28....)			M1	
			46.3		A1	for 46.2 – 46.3
						Total 5 marks

10		(8 =) 2 × 2 × 2 or 2^3 or 2^{3+n}		2	M1	For clearly writing 8 as a product of prime factors or as 2^3
			$2^{n+3}\times 3\times 5^m$		A1	
						Total 2 marks

11	$(AC^2 =)\ 17^2 - 15^2$		5	M1
	$(AC =)\sqrt{17^2 - 15^2}\ (=\sqrt{64} = 8)$			M1
	$\frac{\pi \times '8'}{2} (= 4\pi = 12.566...)$			M1 dep on M2 for $\frac{\pi \times '8'}{2}$ oe or 4π 12.5663…
	'12.566…'+ 15 + 17			M1 for '12.566' + 15 + 17 and no additional values
		44.6		A1 for awrt 44.6
				Total 5 marks
Alternative mark scheme for 11				
	$\cos^{-1}\left(\frac{15}{17}\right) (= 28.0724)$ or $\sin^{-1}\left(\frac{15}{17}\right) (= 61.9275)$		5	M1 for a correct method to find one of the angles
	15 × tan ('28.0724')(= 8) or 15 ÷ tan ('61.9275')(= 8)			M1
	$\frac{\pi \times '8'}{2}$ (= 4π = 12.566…)			M1 dep on M2 for $\frac{\pi \times '8'}{2}$ or 12.5663… or 4π
	"12.566" + 15 + 17			M1 for "12.566" + 15 + 17 and no additional values
		44.6		A1 for awrt 44.6
				Total 5 marks

8		$8^2 + 15^2$ (= 289)		5	M1
		$\sqrt{8^2 + 15^2}$ (=17)			M1
		$\pi \times \left("\frac{17}{2}"\right)^2$ (= 226.98...) **or** 0.5 × 15 × 8 (= 60)			M1
		$\pi \times \left("\frac{17}{2}"\right)^2 - 0.5 \times 15 \times 8$ ("226.98" – "60")			M1
			167		A1 Accept answers which round to 167
					Total 5 marks

9			$2^4 \times 3^2 \times 5^4 \times 11 \times 13$	2	B2 (B1 for 12 870 000 or correct unsimplified product or $2^m \times 3^n \times 5^p \times 11 \times 13$ with at least 1 of m, n or p correct or for $2^4 \times 3^2 \times 5^4$)
					Total 2 marks

20	75 × 2 (=150)		5	M1	"150" for *AOC* may be seen on diagram.
	$\frac{"150"\times\pi r^2}{360}$ oe (= $1.309r^2$ or $\frac{5\pi}{12}r^2$)			M1	dep 1st M1
	0.5 × sin ("150") × r^2 oe (= $0.25r^2$)			M1	dep 1st M1 a complete method to find the area of triangle *OAC* in terms of *r*
	eg $\frac{150\pi}{360}r^2 - 0.5\sin(150)r^2 = 200$ oe or $(1.309... - 0.25)r^2 = 200$			M1	correct equation in r^2 or rearranged to make r^2 or *r* the subject.
		13.7		A1	accept 13.7 – 13.8
					Total 5 marks

8	22 × 260 (= 5720) or 50 × 218 (= 10 900)		3	M1
	$\frac{'10900' - '5720'}{28}$ $\left(= \frac{5180}{28}\right)$			M1
		185		A1
				Total 3 marks

9	$\cos 30 = \frac{24}{(AC)}$ or $\sin'60' = \frac{24}{(AC)}$ **or** $\frac{\sin'60'}{24} = \frac{\sin 90}{(AC)}$ oe		5	M1 for correct trig ratio involving *AC*	M2 for use of tan **and** Pythagoras to obtain *AC* $(AB =)\ 24\tan 30\ (=13.856...)$ **and** $\sqrt{'13.856...'^2 + 24^2}\ (=27.712...)$ If not M2, then M1 for use of tan and Pythagoras to obtain AC^2 $(AB =)\ 24\tan 30\ (=13.856...)$ **and** $'13.856...'^2 + 24^2\ (=768)$
	$(AC =) \frac{24}{\cos 30}\ (= 16\sqrt{3} = 27.712\ldots)$ or $(AC =) \frac{24}{\sin'60'}\ (= 16\sqrt{3} = 27.712\ldots)$ **or** $(AC =) \frac{24\times\sin 90}{\sin'60'}$			M1 for a correct trig ratio for *AC*	
	$\frac{1}{2}\times 2\times\pi\times 3\ (= 3\pi = 9.424\ldots)$			M1 for using $\pi\times 2\times 3$ or $2\pi\times 3$	
	'27.712…' + '9.424…' – 2×3			M1 for a complete method to find the length *AFEDC*	
		31		A1 accept answers in range from 31 to 31.15	
				Total 5 marks	

19	$\pi\times(r+7)^2\times\frac{45}{360}$ oe or $(2\times)\pi\times(r-2)^2$ oe		5	M1
	$\pi\times(r+7)^2\times\frac{45}{360}=2\times\pi\times(r-2)^2$ oe			M1 for a correct equation
	E.g. $675r^2-3510r+675(=0)$ $15r^2-78r+15(=0)$ oe or $5r^2-26r+5(=0)$ oe Allow $5r^2-26r=-5$ or $[4(r-2)]^2=(r+7)^2$ or $(r-2)^2=\left[\frac{(r+7)}{4}\right]^2$			A1 (dep on M2) writing a correct quadratic expression in form $ax^2 + bx + c$ (= 0) allow $ax^2 + bx = c$
	$(5r-1)(r-5)(=0)$ oe or $(r=)\ \frac{--26\pm\sqrt{(-26)^2-4\times5\times5}}{2\times5}$ or $5\left(\left(r-\frac{26}{10}\right)^2-\left(\frac{26}{10}\right)^2\right)+5=0$ oe or $4r-8=r+7$ oe			M1 (dep on M1) for a complete method to solve their 3-term quadratic equation Allow one sign error and some simplification – allow as far as $\frac{26+\sqrt{676-100}}{10}$
		5		A1 dep on M2 (5 and $\frac{1}{5}$ scores M1M1A1M1A0)
				Total 5 marks

21	$\pi \times 4.8^2 \times \frac{72}{360}$ (= 14.4(76…)) oe		5	M1 for finding the area of the sector
	$\frac{1}{2} \times 4.8^2 \times \sin 72$ (= 10.9(56…) or 11) oe or $\frac{1}{2} \times 5.6(4...) \times 3.8(8...)$ oe			M1 for finding the area of the triangle (Allow use of cosine rule/sine rule/SOHCAHTOA/Pythagoras to find *AC* (5.6(427.8…)) and *OM* (3.8(8328…)) where *M* is the midpoint of *AC*)
	"14.4(76…)" – "10.9(56…)" (= 3.520…)			M1 for finding the shaded area with all figures from correct working
	"3.5(20…)" × 14 × 3 × 60 "3.5(20…)" × 2520			M1
	Award marks within the range from correct working	8870		A1 accept 8820 – 8950 from correct working
				Total 5 marks

22	$2t + 1 + (n-1)3 = 14t - 5$		4	M1 for the use of *n*th term = $a + (n-1)d$ to find *n*
	$(n =) 4t - 1$ or $(n =) -1 + 4t$			A1
	$(S_n =) \frac{"4t-1"}{2}[2(2t+1) + ("4t-1"-1)3]$ or $(S_n =) \frac{"4t-1"}{2}[2t + 1 + 14t - 5]$ oe			M1 for the use of S_n formula (must be in terms of *t*) Allow their expression for *n* dep on M1
	Working required	$p = 2$ $q = 4$ $r = 2$		A1 dep on M2 allow $(S_n =) 2(4t-1)^2$ Values of *p*, *q* and *r* must come from correct working
				Total 4 marks

4	eg $(AB^2 =)6^2 + 6^2 (= 72)$ **or** $\sin 45 = \frac{6}{(AB)}$ **or** $\cos 45 = \frac{6}{(AB)}$ **or** **or** $(AB^2 =)6^2 + 6^2 - 2\times 6\times 6\times \cos 90$		5	M1	for a correct start to the method to find *AB*
	eg $(AB =)\sqrt{6^2 + 6^2}\ (= \sqrt{72}$ or $6\sqrt{2}$ or $8.48...)$ **or** $(AB =)\frac{6}{\sin 45}\ (= \sqrt{72} = 6\sqrt{2} = 8.48...)$ **or** $(AB =)\frac{6}{\cos 45}\ (= \sqrt{72} = 6\sqrt{2} = 8.48...)$ **or** $(AB =)\sqrt{6^2 + 6^2 - 2\times 6\times 6\times \cos 90}$			M1	for a complete method to find the length of *AB*
	eg $\pi \times 6 (= 6\pi$ or $18.8...)$ **or** $\pi \times 6 \div 2 (= 3\pi$ or $9.42...)$ **or** $\pi \times$"8.48..."$(= 26.6...)$ **or** $\pi \times$"8.48..."$\div 2\ (= 13.3...)$			M1	(indep) for a method to find the circumference of one whole circle **or** the arc length of one semicircle seen (may be embedded)
	eg $2 \times$"3π"+"13.3..." **or** "9.42" + "9.42" + "13.3" **or** "18.8" + "13.3"			M1	for a complete correct method to find the perimeter of the shape
	Correct answer scores full marks (unless from obvious incorrect working)	32.2		A1	accept answers in the range 32.1 – 32.3
					Total 5 marks

21	$(2r)^2 - \pi r^2$ oe or $x^2 - \pi \times (0.5x)^2$		5	M1 A correct expression for the area of the shaded parts in one variable only **for this mark only**, accept without brackets (eg $2r^2 - \pi r^2$ or $x^2 - \pi \times \frac{1}{2}x^2$) (any letter can be used eg *AB*, *x*, *y* etc, here, *r* = radius, *x* = side of square)
	$4r^2 - \pi r^2 = 80$ oe eg $r^2 - 0.25\pi r^2 = 20$ or $x^2 - 0.25\pi x^2 = 80$ or $4x^2 - \pi x^2 = 320$ oe			M1 A correct equation in one variable with brackets expanded (may be seen later in working)
	$r^2 = \frac{80}{4-\pi}$ (= 93.19…) or $r = \sqrt{\frac{80}{4-\pi}}$ (= 9.65…) $x^2 = \frac{80}{1-0.25\pi}$ (= 372.78..) or $x = \sqrt{\frac{80}{1-0.25\pi}}$ (19.307...) oe eg $\sqrt{\frac{320}{4-\pi}}$			M1 A correct expression for the radius squared or radius or for the side of the square squared or for the side of the square
	$(AC =)\sqrt{(2\times"9.65")^2 + (2\times"9.65")^2}$ oe or $(AC =)\ 2\times\sqrt{"9.65"^2 + 9.65"^2}$ $(AC =)\sqrt{"19.307"^2 + "19.307..."^2}$ oe eg $\sqrt{8\times\frac{80}{4-\pi}}$ oe or $(AC =)\frac{2\times"9.65"}{\sin 45}$ or $\frac{2\times"9.65"}{\cos 45}$			M1 For a correct calculation to find the length of *AC*
	Correct answer scores full marks (unless from obvious incorrect working)	27.3		A1 27.3 – 27.5
				Total 5 marks

Question	Working	Answer	Mark	Notes
22	$\pi\times(5r)^2\times\frac{45}{360}$ or $\pi\times(3r)^2\times\frac{45}{360}$ $\pi\times r^2\times\frac{45}{360}$ or $\pi\times(0.6r)^2\times\frac{45}{360}$ $\pi\times(5r)^2\times\frac{45}{360}-\pi\times(3r)^2\times\frac{45}{360}=\frac{81}{2}\pi$ or $\pi\times r^2\times\frac{45}{360}-\pi\times(0.6r)^2\times\frac{45}{360}=\frac{81}{2}\pi$ $r^2 = (40.5 \times 8) \div (1 - 0.36)$ or $r^2 = 506.25$ oe $(r = 22.5)$ $r^2 = (40.5 \times 8) \div (25 - 9)$ or $r^2 = 80.25$ oe $(r = 4.5)$ $(AB =)\ 2\times\pi\times'13.5'\times\frac{45}{360}\left(=\frac{27}{8}\pi\right)$ or $(PQ =)\ 2\times\pi\times'22.5'\times\frac{45}{360}\left(=\frac{45}{8}\pi\right)$ oe Perimeter = $\frac{'27}{8}\pi'+\frac{'45}{8}\pi'+'9'+'9'$	$9\pi+18$	6	M1 oe M2 for $0.64\pi r^2\times\frac{45}{360}=\frac{81}{2}\pi$ or M1 oe $16\pi r^2\times\frac{45}{360}=\frac{81}{2}\pi$ M1 or 1 share = 4.5 or r = 22.5 or OA = 13.5 or AP = 9 M1 dep on M3 or $2\times\pi\times('13.5'+'22.5')\times\frac{45}{360}(=9\pi)$ M1 dep on M4 A1 oe

Question		Working	Answer	Mark		Notes
19		$\frac{25}{2}\pi = \pi r^2 \times \frac{80}{360}$ $r = 7.5$		6	M1 A1	Equation of sector equal to $\frac{25\pi}{2}$ or a calculation that leads to r or r^2
		(APB =) 2 × π × "7.5" × $\frac{80}{360}$ (= 10.471).... *(APB =)* 10.471.... (=10 π /3) (AB^2) = "7.5"² + "7.5"² − (2 × "7.5" × "7.5" × cos80) or $\frac{AB}{\sin 80} = \frac{7.5}{\sin 50}$ or (*AB* =) 2 x "7.5" x sin 40 (*AB* =) 9.6418 "9.6418" + "10.4719"			M1 ft M1ft M1ft	Dep on 1st M1 Accept 10.5 or better Dep on 1st M1 Correct equation to find *AB* (= 9.6) or AB^2 (= 93 or better) must use a clearly identified radius value
			20.1		A1	Dep on 2nd and 3rd method marks awrt 20.1
						Total 6 marks

20		3.455 or 3.465 or 6.25 or 6.35 $\frac{6\times 3.465}{6.25-3.465}$	7.46	3	M1 M1 A1	Accept $3.46\dot{4}9\dot{}$ for 3.465 or $6.34\dot{9}\dot{}$ for 6.35 $\frac{6\times UB_a}{LB_b - UB_a}$ where 3.46 < UB_a ≤ 3.465 and 6.25 ≤ LB_b < 6.3 Dep M2 Accept 7.46499 ...
						Total 3 marks

21		(LSF =)$\sqrt{240 \div 540}$ or $\frac{2}{3}$ or $\frac{3}{2}$ or 1.5 or 3 : 2 or 2 : 3 $\left(\frac{2}{3}\right)^3$ x 2025 oe accept 0.0.66 or better for 2/3	600	3	M1 M1 A1	Full method leading to correct answer
						Total 3 marks

22		eg $(AD =)\sqrt{6^2+6^2-2\times6\times6\times\cos(50)}$ $(=5.07\ldots)$ **or** $2\times6\sin25$ $(=5.07\ldots)$ **or** $\frac{6\sin50}{\sin65}(=5.07\ldots)$ oe		6	M1	Correct expression for AD ie $AD = \ldots$ or $x =$ oe
		eg $6+6+\sqrt{6^2+6^2-2\times6\times6\times\cos(50)}$ or $12+$"5.07…" $(=17.0)7\ldots$ or 17.1)			M1	A **correct** statement of perimeter of triangle OAD
		eg (arc BC=) $\frac{50}{360}\times\pi\times2\times(6+x)$ oe			M1	A correct statement for arc BC (condone missing brackets around $(6 + x)$ for this mark only)
		eg $2\times"17.1"=12+2x+\frac{50}{360}\times\pi\times2\times(6+x)$ oe			M1	dep on M3 for a correct equation for x
		eg $2\times17.1-12-\frac{30}{18}\pi=2x+\frac{5x}{18}\pi$			M1	isolating terms in x in a correct equation
			5.89		A1	5.88 – 5.89
						Total 6 marks

25	[chord AB =] $\sqrt{5^2+5^2-2\times5\times5\times\cos 50}$ **or** $2\times5\times\sin 25$ (= 10sin25 or 4.226...)		6	M1 oe
	[$\angle APB$ =] $\cos^{-1}\left(\frac{4^2+4^2-"4.226..."^2}{2\times4\times4}\right)$ (=63.77...) **or** [$\angle OPA$ =] $\sin^{-1}\left(\frac{0.5\times"4.226..."}{4}\right)$ (= 31.88...)			M1 oe may use other methods but must be a complete method for $\angle APB$ **or** $\angle OPA$ (see below for sine rule)
	[Area sector AOB =] $\frac{50}{360}\times\pi\times5^2$ $\left(=\frac{125}{36}\pi \text{ or } 10.9...\right)$			M1 oe independent
	[Area sector APB =] $\frac{"63.77..."}{360}\times\pi\times4^2$ (= 8.90...)			M1 oe NB: 2 × "31.88…" = "63.77…"
	$\left(\frac{50}{360}\pi\times5^2-\frac{1}{2}\times5^2\times\sin 50\right)+\left(\frac{"63.77..."}{360}\times\pi\times4^2-\frac{1}{2}\times4^2\times\sin"63.77..."\right)$			M1 oe (10.9…– 9.57…) + (8.90… – 7.17…)
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	3.06		A1 allow 3 – 3.1
	Alternative version (using line of symmetry OP in quadrilateral $OAPB$)			**Total 6 marks**
	[$\angle OPA$] $=\sin^{-1}\left(\frac{5\sin 25}{4}\right)$ (= 31.88..)		6	M1 oe (see above for cosine rule & trig)
	[Area sector APB =] $\frac{2\times"31.88..."}{360}\times\pi\times4^2$ (= 8.90...)			M1 oe
	[Area $OAPB$ =] 2 × ½ × 5 × 4 × sin(180 – "31.88.." – 25) (=16.75...)			M1 oe
	[Area sector AOB =] $\frac{50}{360}\times\pi\times5^2$ $\left(=\frac{125}{36}\pi=10.9...\right)$			M1 oe independent
	[Area **R** =] "10.9..." + "8.90..." – "16.75..."			M1 oe
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	3.06		A1 allow 3 – 3.1
				Total 6 marks

22	(radius of large circle =) $\frac{4}{\cos 54}$ **or** $\frac{4}{\sin 36}$ **or** $\frac{8\sin 54}{\sin 72}$ **or** $\sqrt{\frac{8^2}{2-2\cos 72}}$ (= 6.805...) **or** (height of 1 triangle within pentagon =) 4tan54 (=5.505...) oe		6	M1 for a complete method to find the radius of the large circle **or** the perpendicular height of one triangle within the pentagon
	(area of large circle =) $\pi\times(\text{"6.805..."})^2$ (= 145.489...) oe **or** (area of sector =) $\frac{72}{360}\times\pi\times(\text{"6.805..."})^2$ (= 29.097...) oe			M1 for a complete method to find the area of the large circle **or** the area of a sector of the large circle
	(area of pentagon =) 5 × ½ × 8 × "5.505..." (= 80tan54 = 110.11...) **or** 10 × ½ × 4 × "5.505..." (= 80tan54 = 110.11...) **or** 5 × ½ × "6.805..." × "6.805..." × sin72 (= 110.11...) oe **OR** (area of one triangle =) ½ × 8 × "5.505..." (= 22.022...) **or** ½ × "6.805..." × "6.805..." × sin72 (= 22.022...) **or** ½ × "6.805..." × 8 × sin54 (= 22.022...) oe			M1 for a complete method to find the area of the pentagon **OR** the area of one triangle eg *OED* or equivalent
	$\text{"145.489..."}-\text{"110.11..."}+\pi r^2=\text{"110.11..."}-\pi r^2$ oe **or** $5\times(\text{"29.097..."}-\text{"22.022..."})+\pi r^2=5\times\text{"22.022..."}-\pi r^2$ oe			M1 for a correct equation for the radius of the smaller circle
	$2\pi r^2=2\times\text{"110.11..."}-\text{"145.489..."}$ (= 74.731...) oe			M1 for a correct rearranged equation with the area of the circle the subject or better
	Correct answer scores full marks (unless from obvious incorrect working)	3.45		A1 accept 3.43 – 3.45
				Total 6 marks

25	eg $\frac{40}{360}\pi r^2 - \frac{1}{2}r^2\sin 40 (= 28)$ oe **or** $\frac{40}{360}\pi r^2 = 28 + \frac{1}{2}r^2\sin 40$ oe		6	M1	for a correct expression for the area of the shaded region Allow 3.14… or $\frac{22}{7}$ for π sin 40 = 0.64…
	(radius ^{2} =) 992 – 1024 (radius =) 31.8(096…)	31.8		A1	Allow answers in the range 31.5 – 32.0
	eg $(BC^2 =) 2\times"31.8"^2 - 2\times"31.8"^2\cos 40 (= 473.4...)$ **or** $\frac{0.5BC}{"31.8"} = \sin 20$ **or** $\frac{BC}{\sin 40} = \frac{"31.8"}{\sin(70)}$			M1	for a correct first step to find *BC* using **their clearly identified radius** eg *r* = …. or seen on diagram NB $\frac{180-40}{2} = 70$ sin 20 = 0.34… sin 70 = 0.93… or 0.94
	eg $(BC =)\sqrt{2\times"31.8"^2 - 2\times"31.8"^2\cos 40} (= 21.7...)$ **or** $(BC =) 2\times"31.8"\sin 20 (= 21.7...)$ **or** $BC = \frac{"31.8"\sin 40}{\sin(70)} (= 21.7...)$			M1	dep on previous M1 for a complete method to find *BC* cos 40 = 0.76… or 0.77
	eg $\frac{130}{360}\times 2\times\pi\times"21.7"$			M1	dep on previous M1 for a complete method to find the length of arc *BD*
	Correct answer scores full marks (unless from obvious incorrect working)	49.4		A1	accept 48.9 – 49.7
					Total 6 marks

					Total 4 marks

4		$\pi \times 7^2 \times 20$ (= 3078.76...) **or** 980π			M1 for complete method to find volume
			3080	2	A1 for answer in range 3077.2 – 3080
					Total 2 marks
5	(a)	4 × 120 (= 480)			M1
		e.g. 120 ÷ 2 × 5 (= 300) **or** 120 × 0.4 × 7 (= 336) **or** (120 – '60' – '48') × 8 (= 96) **or** 120 × 0.1 × 8 (= 96)			M1 for a method to find the income for one of the selling prices
		e.g. (120 ÷ 2 × 5) + (120 × 0.4 × 7) + ((120 – '60' – '48') × 8) (= 732) **or** (120 ÷ 2 × 5) + (120 × 0.4 × 7) + (120 × 0.1 × 8) (= 732) **or** '300' + '336' + '96' (= 732)			M1 for a complete method to find the total income
		e.g. $\frac{'732' - '480'}{'480'} \times 100$ **or** '252' ÷ '480' × 100 **or** $\left(\frac{'732'}{'480'} \times 100\right) - 100$ or 152.5 – 100 **or** $\left(\frac{'732'}{'480'} - 1\right) \times 100$ or 0.525 × 100			M1 for a complete method to find the percentage profit
			52.5	5	A1 accept 53
	(b)	e.g. 1 + 0.2 (= 1.2) **or** 100(%) + 20(%) (= 120(%)) **or**			M1

International GCSE Maths					
Apart from Questions 3, 7b, 12, 17, 20, 22 the correct answer, unless clearly obtained by an incorrect method, should be taken to imply a correct method					
Q		**Working**	**Answer**	**Mark**	**Notes**
1	(a)		x^7	1	B1
	(b)	eg $7^8 \times 7^4 = 7^{12}$ or $7^8 \div 7^3 = 7^5$ or $7^5 \times 7^4$ or $7^4 \div 7^3 = 7$ or $7^8 \times 7$ or $7^{'12'} \div 7^3 = 7^{'12'-3}$		2	M1 for one correct step – must be written as a power of 7
			7^9		A1 for 7^9
					Total 3 marks

2	32.4×100^3		2	M1 for 32.4×100^3 oe
		32 400 000		A1 for 32 400 000 accept 3.24×10^7
				Total 2 marks

International GCSE Maths
Apart from questions 5a, 10, 18a, 19, 22, 23, 24 (where the mark scheme states otherwise) the correct answer, unless clearly obtained from an incorrect method, should be taken to imply a correct method.

Question	Working	Answer	Mark	Notes
1	e.g. $\pi \times 8.2^2$ (= 211.24..., $\frac{1681}{25}\pi$) **or** 1.5 × 1000 (= 1500) **or** $\pi \times 8.2^2 \times 10$ (= 2112.4..., $\frac{3362}{5}\pi$)		3	M1 for a correct first step
	e.g. (1.5 × 1000) ÷ ($\pi \times 8.2^2$) (= 7.1009...) **or** (1.5 × 1000) ÷ "2112.4" × 10 oe (= 7.1009...) **or** 10 – (("2112.4" – 1.5 × 1000) ÷ ($\pi \times 8.2^2$)) (= 7.1009...)			M1 for a complete method to find the depth of the water or an answer of 2.89 – 2.91
		7.1		A1 accept 7.09 – 7.11
				Total 3 marks

2	Ext ∠ = 180 – 162 (= 18) oe **or** $\frac{(n-2)180}{n} = 162$ oe		3	M1
	360 ÷ "18" oe **or** 18n = 360			M1
		20		A1
				Total 3 marks

Question	Working	Answer	Mark	Notes
12	180 – 2 × 66 (= 48) (360 – "48") ÷ 2 (= 156) 180 – "156" (= 24) 360 ÷ "24"		3	M1 Could be marked on diagram M1ft Final stage of calculation
	Alt : 180 – 2 × 66 (= 48) 360 ÷ (0.5 × "48")			M1 Could be marked on diagram M1ft Final stage of calculation
	Alt:180 – 2 × 66 (= 48) (360 – "48") ÷ 2 (= 156) $\frac{180\,(n-2)}{n}$ = "156" "24"n = 360 or $\frac{180\,(15-2)}{15}$ (= 156)			M1 Could be marked on diagram M1ft Final stage of calculation or embedded correct answer.
		15		A1
				Total 3 marks

13	$\frac{h}{2}$ × (7+12) × 10 = 608 oe		3	M2 M1 for $\frac{h}{2}$ × (7 + 12) × 10
		6.4		A1
				Total 3 marks

14	5, 7, 11, 12, 13, 14, 15, 16, 17, 18, 18		3	M1 Ordering marks (allow 1 error)
	11 and 17 selected			M1 LQ = 11 and UQ =17 identified
		6		A1
				Total 3 marks

15 (a)		2, −1.5, −3, 0	2	B2 B1 for 2 or 3 values correct
(b)			2	M1ft At least 5 points plotted correctly ft from table dep on B1 in part (a)
				A1 For correct smooth curve.
				Total 4 marks

2			3	M1	For area of 2 different faces (ie not 2 triangles)
	0.5 × 4.8 × 3.6 (= 8.64) oe or 4.8 × 3.6 if clear intention for this to be 2 triangles 7 × 3.6 (= 25.2) 7 × 4.8 (= 33.6) 7 × 6 (= 42) (**all measurements with intention to add**)			M1	For adding together 5 areas , at least 4 of which are correct NB: (3.6 + 4.8 + 6) × 7 (= 100.8) is 3 faces
	Correct answer scores full marks (unless from obvious incorrect working)	118		A1	118.1 or 118.08
					Total 3 marks

3		(x =) 3	3	B1	
		(y =) 6		B1	
		(z =) 10		B1	
					Total 3 marks

4	1600 × 0.16 (= 256) oe or 1 – 0.16 (= 0.84) oe		4	M1	
	1600 – "256" or 1600 × "0.84" (= 1344)			M1	
	$\frac{"1344"}{1400}(=0.96)$ **or** $\frac{1400-"1344"}{1400}(=0.04)$ **or** $\frac{"1344"}{1400}\times 100(=96)$ **or** $\frac{1400-"1344"}{1400}\times 100$			M1	
	Correct answer scores full marks (unless from obvious incorrect working)	4		A1	SCB1 for 1856 seen if no other marks awarded
					Total 4 marks

				Total 5 marks

Question	Working	Answer	Mark	Notes
21	$r = \sqrt{\frac{49\pi}{4\pi}}$ oe (= 3.5)		3	M1
	[volume =] $\frac{4}{3} \times \pi \times$ "3.5"^{3}			M1
	Correct answer scores full marks (unless from obvious incorrect working)	180		A1 awrt 180
				Total 3 marks

17	(a)	15 ÷ 15 (= 1) 18 ÷ 5 (= 3.6) 32 ÷ 20 (= 1.6) 4 ÷ 10 (= 0.4)	Correct histogram	3	B3	for a fully correct histogram If not B3 then B2 for 3 correct frequency densities (can be implied by heights) or 3 correct bars drawn If not B2 then B1 for 2 correctly calculated frequency densities (can be implied by heights) or 2 correct bars drawn
						SC: award B2 for all 4 bars of correct width with heights in the correct ratio (eg drawn at 0.5, 1.8, 0.8, 0.2) **SC:** award B1 for 3 bars of correct width with heights in the correct ratio
	(b)	eg $\frac{15}{20}\times 32(=24)$ **or** $\frac{5}{20}\times 32(=8)$ **or** $\frac{15}{20}\times 32+18(=42)$ **or** $32+18-\frac{5}{20}\times 32(=42)$		2	M1 ft	for a method to find an estimate for the number of students who took between 30 and 45 minutes **or** between 45 and 50 minutes **or** between 25 and 45 minutes ft incorrect histogram
		Correct answer scores full marks (unless from obvious incorrect working)	$\frac{42}{50}$		A1	oe eg $\frac{21}{25}$, 0.84, 84%
						Total 5 marks

18	$\sqrt{\frac{3600}{625}}$ **or** $\frac{12}{5}$ oe **or** 2.4 **or** 12:5 oe **or** $\sqrt{\frac{625}{3600}}$ **or** $\frac{5}{12}$ oe **or** 0.416.... **or** 5:12 oe **or** $\frac{3600^3}{625^3}=\frac{(\text{vol of statue})^2}{750^2}$ oe **or** $\frac{3600}{625}=\frac{(\text{vol of statue})^{\frac{2}{3}}}{750^{\frac{2}{3}}}$ oe		3	M1 for a correct length scale factor **or** a correct length ratio **or** setting up a correct equation involving the volume of the statue
	eg $750\times\left(\frac{"12}{5"}\right)^3$ oe **or** $750\div\left(\frac{"5}{12"}\right)^3$ oe **or** $\sqrt{\frac{3600^3\times750^2}{625^3}}$ oe **or** $\left(\frac{3600\times750^{\frac{2}{3}}}{625}\right)^{\frac{3}{2}}$ oe			M1 (dep on M1) for a correct method to work out the volume of the statue
	Correct answer scores full marks (unless from obvious incorrect working)	10 368		A1 cao
				Total 3 marks

22	$\frac{1}{2}\times\frac{4}{3}\times\pi\times12^3\left(=1152\pi=3619.(114)\right)$ oe or $\frac{1}{2}\times\frac{4}{3}\times\pi\times9^3\left(=486\pi=1526.(814)\right)$ oe or $\frac{4}{3}\times\pi\times12^3\left(=2304\pi=7238(.229)\right)$ oe or $\frac{4}{3}\times\pi\times9^3\left(=972\pi=3053(.628)\right)$ oe		3	M1 for finding the volume of a sphere or a hemisphere
	$\frac{1}{2}\times\frac{4}{3}\times\pi\times12^3-\frac{1}{2}\times\frac{4}{3}\times\pi\times9^3$ oe or "1152π"−"486π"$\left(=666\pi\right)$ oe or $\frac{\frac{4}{3}\times\pi\times12^3-\frac{4}{3}\times\pi\times9^3}{2}$ oe or $\frac{\text{"}2304\pi\text{"}-\text{"}972\pi\text{"}}{2}\left(=\frac{1332\pi}{2}=666\pi\right)$ oe			M1
	Correct answer scores full marks (unless from obvious incorrect working)	2092		A1 2091 – awrt 2093
				Total 3 marks

6	8 × 6 (= 48) 0.5 × 8 × 6 (= 24) 15 × 8 (= 120) 15 × 6 (= 90) 15 × 10 (= 150)		3	M1	For a correct method to find the areas of 2 different faces (ie not 2 triangles) allow 8 × 6 as one area (allow with incorrect areas for this mark)
	0.5 × 8 × 6 (= 24) (× 2 (= 48)) oe 15 × 8 (= 120) 15 × 6 (= 90) 15 × 10 (= 150) (measurements with intention to add for the 2nd M mark) Surface area = "120" + "90" + "150" + "24" + "24" [allow "120" + "90" + "150" + "48" + "48"]			M1	for adding together 4 or 5 values for area (condone 48 as 1 or 2 areas) at least 3 of which are from a correct method NB: (6 + 8 + 10) × 15 (sum must be seen) is 3 faces but only award this if clearly not intended to be the volume – eg by the addition of the area of a triangular end.
	Correct answer scores full marks (unless from obvious incorrect working)	408		A1	cao SCB2 for an answer of 456 if no other marks awarded
					Total 3 marks

7	$3892 = \pi \times 8^2 \times h$ **or** $\pi \times 8^2 \left(= 64\pi = 201...\right)$		3	M1 allow use of 3.14… or $\frac{22}{7}$ for π
	$\left(h =\right) \frac{3892}{\pi \times 8^2}$ oe eg 3892 ÷ 64 = 60.8… **and** 60.8… ÷ π			M1 allow use of 3.14… or $\frac{22}{7}$ for π
	Correct answer scores full marks (unless from obvious incorrect working)	19.4		A1 allow 19.3 – 19.4
				Total 3 marks

8	(a)		5.2×10^8	1	B1
	(b)		0.000 087 9	1	B1
	(c)	35×10^{-138} or $3.5 \times 10 \times 10^{-138}$ or 3.5×10^n where $n \neq -137$		2	M1
		Correct answer scores full marks (unless from obvious incorrect working)	3.5×10^{-137}		A1
					Total 4 marks

<table>
<tr><td>10</td><td>(volume of water =) $9\times35\times28(=8820)$
or (total volume of cuboid =) $20\times35\times28(=19600)$
or (volume of space =) $(20-9)\times35\times28(=10780)$</td><td></td><td>3</td><td>M1 for a method to find a relevant volume for the cuboid</td></tr>
<tr><td></td><td>$\pi\times10^2\times33$ $(=3300\pi$ or $10367(.25...))$ oe</td><td></td><td></td><td>M1 (indep) for a method to find the volume of the cylinder, accept a volume in the range 10362 to 10368.6
Allow 3.14… or $\frac{22}{7}$ for π</td></tr>
<tr><td></td><td>(total volume of water =) “8820” + “10367(.25...)” (= 19187(.25...))
(difference between volumes of both solids =)
“19600” – “10367(.25…)”(= 9232(.74…))
(volume not filled =) “19600” – “8820” – “10367(.25…)”
(=412(.74…))

Working required</td><td>Shown</td><td></td><td>A1 correct workings with accurate figures
eg
<table><tr><td>Value 1</td><td>Value 2</td></tr><tr><td>10780</td><td>10367(.25…) accept 10362 to 10372</td></tr><tr><td>19600</td><td>19187(.25…) accept 19182 to 19192</td></tr><tr><td>8820</td><td>9232(.74…) accept 9228 to 9238</td></tr><tr><td>412(.74…) or 413 accept 408 to 418</td><td>none needed</td></tr></table></td></tr>
<tr><td></td><td></td><td></td><td></td><td>Total 3 marks</td></tr>
</table>

Question	Working	Answer	Mark	Notes
21*	$3x \times 2x \times y = 1014$ oe or $6x^2y = 1014$ oe or $x^2y = 169$ oe		3	M1 for an equation for volume in terms of x and y
	$2\times 3x\times y + 2\times 2x\times y + 2\times 3x\times 2x$ oe or $2\times(3xy + 2xy + 6x^2)$ oe or $6xy + 4xy + 12x^2$ oe or $10xy + 12x^2$ oe			M1 (indep) for a correct expression for the surface area NB May not explicitly see the surface area expression in terms of y eg $2\times 3x\times \frac{169}{x^2} + 2\times 2x\times \frac{169}{x^2} + 2\times 3x\times 2x$ oe May be fully substituted using $y = \frac{169}{x^2}$ oe
	Using $y = \frac{1014}{6x^2}\left(= \frac{169}{x^2}\right)$ in formula for surface area to obtain correct expression eg (SA =) $2\times 5x\times \frac{169}{x^2} + 2\times 6x^2 = 12x^2 + \frac{1690}{x}$ or equating their surface area equations eg $10xy + 12x^2 = 12x^2 + \frac{1690}{x}$ leading to $x^2y = 169$ oe	Shown		A1 dep on M2 For completing the 'show that' by clearly showing the stages that lead to the given expression for the surface area.
	Working required			**Total 3 marks**

Question	Working	Answer	Mark	Notes
16	$1-\frac{98}{125}\left(=\frac{27}{125}\right)$ **or** 0.216 **or** 125 – 98 (=27) $\sqrt[3]{"\frac{27}{125}"}\left(=\frac{3}{5}\right)$ **or** $\sqrt[3]{"\frac{125}{27}"}\left(=\frac{5}{3}\right)$ $1-"\frac{3}{5}"$ **or** $h-"\frac{3}{5}"h$ oe	$\frac{2}{5}h$ oe	4	M1 M1 for the length scale factor may be seen as a ratio E.g. 3 : 5 M1 A1 for $\frac{2}{5}h$ oe (may not be simplified)
	Alternative scheme $\frac{1}{3}\pi r^2h-\frac{1}{3}\pi(kr)^2kh=\frac{98}{125}\times\frac{1}{3}\pi r^2h$ oe $k=\frac{3}{5}$ $1-"\frac{3}{5}"$ **or** $h-"\frac{3}{5}"h$ oe	$\frac{2}{5}h$ oe	4	M1 sets up an equation using scale factor M1 for the length scale factor M1 A1 for $\frac{2}{5}h$ oe (may not be simplified)

7	(a)		$4n + 2$	2	M1	for $4n + k$ (k may be 0 or absent) oe
					A1	oe e.g $6 + (n - 1)4$
	(b)		$4n + 6$	1	B1	oe ft part (a) providing M1 in part (a) is awarded e.g $4(n + 1) + 2$
						Total 3 marks

8	(a)		1.39×10^6	1	B1
	(b)		5×10^{-3}	1	B1
					Total 2 marks

9	2.5 − 0.6 = 1.9	2 hours 51 minutes	4	M1	
	3 × 12 × "1.9" (= 68.4)			M1	for using length × width × height to find a volume
	"68.4" × 1000 ÷ 400 (= 171 minutes)			M1	for their volume × 1000 ÷ 400
				A1	
					Total 4 marks
	Alternative scheme				
	250 − 60 = 190	2 hours 51 minutes	4	M1	
	300 × 1200 × "190" (= 6.84×10^7)			M1	for using length × width × height to find a volume
	"6.84×10^7" ÷ 10^6 × 1000 ÷ 400 (= 171 minutes)			M1	for their volume ÷ 10^6 × 1000 ÷ 400
				A1	
					Total 4 marks

Question	Working	Answer	Mark	Notes
5	$\angle OQT = 90^\circ$ **and** $\angle OQP = 18^\circ$ **or** 90 – 18		3	M1 For 90° **and** 18° correctly identified in the working or on the diagram **or** for 90 – 18 **or** for other fully correct method
		72		A1
	Angle between tangent and radius(or diameter) is 90 degrees			B1 Correct reason for 90° angle [If used alternate segment theorem]
				Total 3 marks

6	(a)	$2 \times \pi \times 0.56 \times 1.6$		2	M1 Award even if part of a calculation including 1 or 2 circles
			5.63		A1 awrt 5.63
	(b)	$\frac{0.6}{1.6}$ (=0.375) **or** $\frac{1.6}{0.6}$ $(=\frac{8}{3}=2.\dot{6})$ **or** $\frac{r}{0.56}=\frac{0.6}{1.6}$ **or** $(r=)\frac{0.56\times0.6}{1.6}$ **or** $0.56 \div 2.\dot{6}$ oe		2	M1 Correct scale factor (given as a fraction or ratio) or correct equation in r or a correct expression for r. Allow 2.6666... to 1 dp rounded or truncated
			0.21		A1 Allow 21 cm oe if units shown
					Total 4 marks

7	(a)	(28 + 32) × 72.6 (=4356) **or** 28 × 75 (=2100)		4	M1 Expression for total of both classes together or total for class A
		(28 + 32) × 72.6 – 28 × 75 (=2256)			M1 Expression for total of class B
		$\frac{(28+32)\times72.6-28\times75}{32}$ (="2256" ÷ 32)			M1 Correct calculation for mean of class B
			70.5		A1
	(b)	Highest in A = 39 + 57 (= 96) Highest in B = 33 + 60 (= 93)		3	M1 for 39 + 57(=96) **or** 33 + 60(=93)
		(39 + 57) – 33			M1 or for 33 – "96" or 33 to "96" oe
			63		A1
					Total 7 marks

Question	Working	Answer	Mark	Notes
15	Eg $\frac{4\pi r^2}{2}\ (+\pi r^2) = 2\pi(2r)h$ oe			M1 for use of, for example, r and $2r$ in an equation condone omission of flat surface area
	$h = \frac{3}{4}r$ **or** $r = \frac{4}{3}h$			A1 for a correct expression for either r or h
	Eg $\frac{1}{2}\times\frac{4}{3}\times\pi\times r^3$ **and** $\pi\times(2r)^2\times"\frac{3}{4}r"$ **OR** $\frac{1}{2}\times\frac{4}{3}\times\pi\times\left("\frac{4}{3}h"\right)^3$ **and** $\pi\times(2\times"\frac{4}{3}h")^2\times h$			M1 dep on award of first M1 ft for candidate's expression for r or h for correct expressions for volume of hemisphere and volume of cylinder ; both in terms of either r or h
		4.5 oe	4	A1

Apart from questions 10b, 11, 12, 21, 22 (where the mark scheme states otherwise) the correct answer, unless clearly obtained from an incorrect method, should be taken to imply a correct method.

Question		Working	Answer	Mark	Notes	
1	(a)		$12 < d \leq 16$	1	B1	
	(b)	$2 \times 16 + 6 \times 18 + 10 \times 19 + 14 \times 27 + 18 \times 20$ $= 32 + 108 + 190 + 378 + 360$ (=1068)	10.68	4	M2	$f \times d$ for at least 4 products with correct mid- interval values and intention to add. If not M2 then award M1 for d used consistently for at least 4 products within interval (including end points) and intention to add or for at least 4 correct products with correct mid-interval values with no intention to add
		'1068' ÷ 100			M1	dep on at least M1 Allow division by their $\sum f$ provided addition or total under column seen
					A1	Accept 10, 10.7 and 11

Question		Working	Answer	Mark	Notes	
2		0.5 × 6 × 6 × 5 (= 90) 0.5 × π × 3² × 5 (=22.5π = 70.6858...) or π × 3² × 5 (=45π = 141.37166...) '90' – '70.6858.....'	19.3	4	M1 M1 M1 A1	Correct method for volume of **A** Correct method for volume of **B** or correct volume of cylinder Correct method to find the difference in the volume 19 – 19.4
3	(a)		$6n + 4$	2	M1 A1	for $6n + k$ (k may be 0 or absent) oe oe eg $10 + (n – 1)6$ or $n \times 6 + 4$
	(b)	...40, 46,... −2, 1, 6, 13, 22, 33 46 ... $6n + 4 = n^2 - 3$ oe	e.g. 22 or 46	2	M1 A1	continuing sequence and writing at least 5 terms of 2nd sequence – allow one error or for a correct equation ft part (a) or other number in both sequences eg −2

17	(a)	eg $\frac{24}{36}$ or 2 : 3 oe **or** $\frac{36}{24}$ or 3 : 2 oe		2	M1	for a correct scale factor
			2160		A1	
	(b)	$\left(\frac{24}{36}\right)^3$ or $2^3 : 3^3$ oe **or** $\left(\frac{36}{24}\right)^3$ or $3^3 : 2^3$ oe or $\frac{8}{27}$ or $\frac{27}{8}$ oe		2	M1	For correct SF for volume ft from linear scale factor in (a) or ft from $\sqrt{\frac{"2160"}{960}}$
			(**A** =) $\frac{8}{27}V$ oe		A1	oe eg $\frac{V}{3.375}$
						Total 4 marks

18		$17.8^2 + 26.3^2 - 2 \times 17.8 \times 26.3 \times \cos 36$		3	M1	
		e.g. 1008.5... – 757.... **or** 251(.06...)			M1	for correct order of operations
			15.8		A1	for ans in range 15.8 – 15.9
						Total 3 marks

3	e.g. 30 × 20 × 125 (= 75 000) **or** 85 × 40 × 125 (= 425 000) **or** $(60\times30+(85-30)\times40)\times125(=500\ 000)$ oe		4	M1	for a method to find the volume of water already pumped out **or** the volume of water left **or** the total volume of the container
	"75 000" ÷ 1.5 (= 50 000) **or** "75 000" ÷ 90 (= 833.3... or $\frac{2500}{3}$) **or** "425000"÷"75000"(= 5.66... or $\frac{17}{3}$) **or** "500000"÷"75000"(= 6.66... or $\frac{20}{3}$)			M1	M2 for $\frac{"425000"}{"75000"}\times 1.5$ oe (= 8.5) **or** $\frac{"500000"}{"75000"}\times 1.5$ oe (= 10)
	"425 000" ÷ "50 000" (= 8.5) **or** "425 000" ÷ ("833.3..." × 60) oe (= 8.5) **or** "5.66…" × 1.5 (= 8.5) **or** "6.66…" × 1.5 (= 10)			M1	
		20 30		A1	Allow 8 30 (pm)
					Total 4 marks

4	(i)		21, 27	1	B1
	(ii)		21, 23, 24, 25, 27, 29	1	B1
					Total 2 marks

4	3.4 or $\frac{17}{5}$ or $3\frac{2}{5}$ or $3\frac{24}{60}$ or 204 oe		3	B1	
	433.5 ÷ 3.4 or 433.5 ÷ $\frac{17}{5}$ or 433.5 ÷ $3\frac{2}{5}$ or $\frac{433.5}{'204'} \times 60$ oe			M1	for use of speed = distance ÷ time Allow 433.5 ÷ 3.24 (= 133.796…) for this mark only
		127.5		A1	oe allow 128
					Total 3 marks

5	a	(x =) 270 ÷ (12 × 5) (= 4.5) oe		3	M1	
		π × '4.5'^{2} × 2 × '4.5' (= 182.25π oe)			M1	ft dep on M1
			573		A1	accept 572 − 573
	b		1 000 000	1	B1	or (1 ×) 10^6 or (one or 1) million oe
						Total 4 marks

6	a	e.g. $A + 5z = \frac{c}{y}$ oe **or** $Ay = c - 5yz$ oe		2	M1	for a correct first step e.g. add 5z to both sides **or** multiply all terms by y
			$c = y(A + 5z)$		A1	oe
	b		1	1	B1	
	c	(x ± 3)(x ± 8)		2	M1	or for (x ± a)(x ± b) where ab = 24 or $a + b = -11$
			(x − 3)(x − 8)		A1	
						Total 5 marks

Question	Working	Answer	Mark	Notes
19	eg $\sqrt{\frac{25}{64}}\left(=\frac{5}{8}=0.625\right)$ **or** $\sqrt{\frac{64}{25}}\left(=\frac{8}{5}=1.6\right)$ **or** $\sqrt{25}:\sqrt{64}\ (5:8)$ **or** $\sqrt{64}:\sqrt{25}\ (8:5)$ **or** $\frac{(\sqrt{25})^3}{(\sqrt{64})^3}=\left(\frac{125}{512}=0.244140625\right)$ oe **or** $\frac{512}{125}=4.096$ $\frac{25^3}{64^3}=\frac{(\text{vol of }\mathbf{B})^2}{(\text{vol of }\mathbf{B}+541.8)^2}$ **or** $\frac{25}{64}=\frac{(\text{vol of }\mathbf{B})^{\frac{2}{3}}}{(\text{vol of }\mathbf{B}+541.8)^{\frac{2}{3}}}$ oe		4	M1 for a correct scale factor for length – may be given as a fraction or decimal or ratio **or** a correct scale factor for volume given as a fraction or decimal or ratio **or** a correct equation for the volume of vase **B**
	eg $\mathbf{B}\left(\frac{512}{125}-1\right)=541.8$ **or** $3.096\mathbf{B}=541.8$ oe **or** eg $\mathbf{A}\left(1-\frac{125}{512}\right)=541.8$ **or** $\frac{387}{512}\mathbf{A}=541.8$ $(8^3)k-(5^3)k(=387k)=541.8$ **or** eg $(k=)\frac{541.8}{387}\left(=\frac{7}{5}\right)$			M1 For a correct equation for the volume of **B** or a correct equation for the volume of **A**
	eg $(\mathbf{B})\ 541.8\div"\frac{387}{125}"$ **or** $541.8\div$"3.096" **or** eg $125\times"\frac{7}{5}"$ or $(\mathbf{A})\ 541.8\div"\frac{387}{512}"(=716.8)$ oe			M1 For a completely correct method to find the volume of vase **B** or vase **A**
	Correct answer scores full marks (unless from obvious incorrect working)	175		A1 cao
				Total 4 marks

6	(a)	$\pi \times 8^2 \times h = 1208$ oe **or** $\frac{1208}{\pi \times 8^2}$ oe		2	M1	for setting up an equation in h using the volume of the cylinder **or** a correct calculation for h (may be seen in stages)
		Correct answer scores full marks (unless from obvious incorrect working)	6		A1	accept 6 – 6.02
	(b)	$\frac{m}{1208} = 1.25$ oe **or** (m =) 1208 × 1.25 (= 1510)		2	M1	for setting up an equation using $D = M / V$ **or** for a calculation to find the mass (may convert mass to kg first)
		Correct answer scores full marks (unless from obvious incorrect working)	1.51		A1	
						Total 4 marks

5	$\pi \times 70^2 \times 18$ oe or $\pi \times 0.7^2 \times 0.18$ oe		4	M1 for use of $\pi r^2 h$
	88200π or 277 088(.472)) or 0.0882π or $\frac{441}{5000}\pi$ or 0.277(088472)			A1 Allow 276 948 – 277 200 or Allow 0.276 948 – 0.277 200
	"277 088(.472)" ÷ 1000 (= 277.088…) or $88200\pi \div 1000$ (= 88.2π or $\frac{441}{5}\pi$) "0.277(088472)" × 1000 (= 277.088…) or $88200\pi \div 1000$ (= 88.2π or $\frac{441}{5}\pi$)			M1 Allow a value for their volume which contains $\boldsymbol{\pi}$, **70** and **18** to be divided by 1000 Allow a value for their volume which contains $\boldsymbol{\pi}$, **0.7** and **0.18** to be multiplied by 1000
	Correct answer scores full marks (unless from obvious incorrect working)	277		A1 awrt 277
				Total 4 marks

22	$\frac{4}{3}\times\pi\times R^3-\frac{4}{3}\times\pi\times1.2^3$ or $\frac{4}{3}\times\pi\times(1.2+t)^3-\frac{4}{3}\times\pi\times1.2^3$	3.9	5	M1	for an expression for the volume of the inner sphere
	$\left(\frac{4\pi}{3}R^3-\frac{4}{3}\times\pi\times1.2^3\right)\times2700=1980$			M1	
	$\frac{4\pi}{3}R^3=\frac{4}{3}\times\pi\times1.2^3+\frac{1980}{2700}$ = 7.238229474 + 0.7333333 = 7.97(1562807)			M1	for a correct expression **or** sight of 7.23(8229474) + 0.73(33333) **or** sight of 7.97(1562807)
	$R=\sqrt[3]{\left(\frac{3}{4\pi}\times(\frac{4}{3}\times\pi\times1.2^3+\frac{1980}{2700})\right)}$ =1.2392… 1.2392 − 1.2 = 0.0392			M1	for a correct expression **or** sight of $\sqrt[3]{1.90(3070437)}$ **or** sight of 1.23(9229151) **or** sight of 0.0392(29151)
				A1	for 3.9 – 3.92
					Total 5 marks

23	(First term = 3 and last term = 999) or a = 3 and d = 3	166 833	4	M1	
	999 ÷ 3 (= 333)			M1	for finding the number of terms Allow 1000÷3 = 333.3 = 333
	Sum = $\frac{333}{2}(3+999)$ or Sum = $\frac{333}{2}(2\times3+(333-1)3)$			M1	for using a correct method to find the sum
				A1	
					Total 4 marks

Question		Working	Answer	Mark	Notes
17	(a)	$2\pi r^2 + 2\pi r \times 2r$	$6r^2$	2	M1 A1
	(b)	S.A. $6\pi r^2 : 4\pi r^2 = 3 : 2$	Shown	3	M1 ft their answer from (a), must be in terms of r. Ratios could be seen as fractions throughout eg $\frac{3}{2}$
		$V_c : V_s = 2\pi r^3 : \frac{4}{3}\pi r^3$			M1
		$= 3 \times 2 : 4 = 3 : 2$			A1 oe eg ratios could be $\frac{3}{2}:1$

21		$h = 3r$ or $r = \frac{h}{3}$		5	M1 for $h = 3r$ **or** $r = \frac{h}{3}$ oe stated or used correctly
		$\frac{1}{2} \times \frac{4}{3} \times \pi r^3$ oe **or** $\pi \times r^2 \times 3r$ oe			M1 **or** $\frac{1}{2} \times \frac{4}{3} \pi \left(\frac{h}{3}\right)^3$ or $\pi \left(\frac{h}{3}\right)^2 h$
		$\frac{1}{2} \times \frac{4}{3} \times \pi r^3 + \pi \times r^2 \times 3r = 792\pi$ oe			M1 **or** $\frac{1}{2} \times \frac{4}{3} \pi \left(\frac{h}{3}\right)^3 + \pi \left(\frac{h}{3}\right)^2 h = 792\pi$
		(r =) 6 or (h =) 18			A1
			24		A1ft their "6" × 4 **or** "18"$\times \frac{4}{3}$ correctly evaluated dep on M3
					Total 5 marks

20	$\frac{1}{3}\times\pi\times r^2\times 2h\left(=\frac{2}{3}\pi r^2h\right)$ **OR** $\frac{1}{3}\times\pi\times(0.5r)^2\times h\left(=\frac{1}{12}\pi r^2h\right)$			M1	for finding the volume of the small or large cone
	$"\frac{2}{3}\pi r^2h" - "\frac{1}{12}\pi r^2h"\left(=\frac{7}{12}\pi r^2h\right)$			M1	(dep) method to find the volume of the frustum (condone missing brackets)
	$"\frac{2}{3}\pi r^2h" - "\frac{1}{12}\pi r^2h" = \frac{4\pi r^3}{3}$			M1	equating volume of frustum and sphere (must be correct including brackets)
	e.g. $\frac{7}{12}\pi r^2h = \frac{4\pi r^3}{3}$			M1	for a correct simplified formula (1 term on each side)
		$\frac{7}{16}h$	5	A1	accept $0.4375h$
					Total 5 marks

21	$CB = 13\sin 40$ (= 8.3562...)			M1
	$\frac{1}{2}\times 6\times "8.35..."\times \sin ACB = 22$			M1
	Acute version of $ACB = \sin^{-1}\left(\frac{22}{\frac{1}{2}\times 6\times "8.35..."}\right)$ (= 61.35…)			M1
	$ACB = 180 - $ "61.353…" (= 118.647...)			M1
	$AB^2 = 6^2 + "8.35..."^2 - 2\times 6\times "8.35..."\times\cos "118.64"$ (= 153.98...)			M1
		12.4	6	A1 accept 12.3 – 12.5
				Total 6 marks

9	$\pi \times 3^2 \times h = 72\pi$ oe			M1	Allow use of 3.14... or $\frac{22}{7}$ for π and use of 226... for 72π
	$h = 72\pi \div (\pi \times 3^2)$ oe **or** $h = 8$			M1	method to isolate h (may be seen in several stages)
	$2 \times \pi \times 3^2$ (= 18π or 56.54...) **or** $2 \times \pi \times 3 \times$ "8" oe (= 48π or 150 - 151)			M1	method to find the area of the two circles **or** curved surface area – use of their h, dep on 1st M1 (NB may get this mark for total area of 2 circles with no previous marks awarded)
	$2 \times \pi \times 3^2 + 2 \times \pi \times 3 \times$ "8" oe (= 66π)			M1	method to find total surface area ft their h dep on 1st M1, including intention to add, to find the total surface area
		207	5	A1	accept 207-208
					Total 5 marks

17	e.g. $(V=)\ \frac{1}{2}\left(\frac{4}{3}\pi x^3\right)+\pi x^2(20-4x)$ **or** $(V=)\ \frac{2}{3}\pi x^3+20\pi x^2-4\pi x^3$		5	M1	for a correct expression
	e.g. $\frac{1}{3}\pi y=\frac{1}{2}\left(\frac{4}{3}\pi x^3\right)+\pi x^2(20-4x)$ **or** $\frac{1}{3}\pi y=\frac{2}{3}\pi x^3+20\pi x^2-4\pi x^3$			M1	for a correct equation
	$y=60x^2-10x^3$ oe			A1	for writing y in terms of x
	e.g. $\left(\frac{dy}{dx}=\right)120x-30x^2=0$ oe			M1	for differentiating their $ax^2 + bx^3$ and equating to 0
		320		A1	(dep on M3) cao
					Total 5 marks

18	e.g. $40+8\sqrt{x}-5\sqrt{x}-\sqrt{x}\sqrt{x}$ **or** $40+8\sqrt{x}-5\sqrt{x}-\left(\sqrt{x}\right)^2$ **or** $40+8\sqrt{x}-5\sqrt{x}-x$ **or** $40+3\sqrt{x}-x$		3	M1	for a correct expansion with at least 3 out of 4 terms correct oe or all 3 terms correct
		$x = 19$		A1	(dep on M1) for $x = 19$
		$y = 3$		B1	for $y = 3$
					Total 3 marks

Question	Working	Answer	Mark	Notes
10	$11.2^2 - 7.4^2$ (= 70.68) or $[x =]\cos^{-1}\left(\frac{7.4}{11.2}\right)(= 48.64...)$ or $[y =]\sin^{-1}\left(\frac{7.4}{11.2}\right)(= 41.35...)$ or $\sin^{-1}\left(\frac{7.4\sin 90}{11.2}\right)$		5	M1 A correct first stage to finding the perpendicular height of the triangular cross section
	eg $\sqrt{11.2^2 - 7.4^2}$ (= 8.407...) **or** $[h =]\sin"48.64..."\times 11.2$ **or** $\tan"48.64..."\times 7.4 (= 8.407...)$ **or** $[h =]\cos"41.35..."\times 11.2$ **or** $\frac{7.4}{\tan"41.35..."}$ (=8.407…)			M1 oe eg $h = \frac{11.2\sin"48.64..."}{\sin 90}$
	eg 7.4 × "8.407" ÷ 2 (= 31.10....) **or** 7.4 × "8.407" × 15 (= 933.19...)			M1 for method to find area of cross section **or** volume of cuboid
	eg "31.10" × 15 (= 466.59...) **or** "933.19" ÷ 2 (= 466.59...)			M1 complete method to find volume of the prism
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	467		A1 accept 466 – 467 SCB2 (if M0 awarded) for $0.5 \times 7.4 \times \sqrt{11.2^2 + 7.4^2} \times 15$ (= 745) **or** SCB1 (if M0 awarded) for $7.4 \times \sqrt{11.2^2 + 7.4^2} \times 15$ (= 1490) or $0.5 \times 7.4 \times \sqrt{11.2^2 + 7.4^2}$ (=49.6…) or 0.5 × 7.4 × 11.2 × 15 (= 621.6) or 622
				Total 5 marks

22	$580\pi = \pi \times 20 \times l$ oe		5	M1 for correct substitution into $A = \pi rl$
	$(l =)\dfrac{580\pi}{20\pi}(= 29)$			M1
	$\sqrt{"29"^2 - 20^2}\ (= \sqrt{441} = 21)$			M1
	$\left(\frac{1}{2} \times \frac{4}{3} \times \pi \times 20^3\right) + \left(\frac{1}{3} \times \pi \times 20^2 \times "21"\right)$ or $\frac{16\,000}{3}\pi + \frac{8400}{3}\pi$ or $\frac{16\,000}{3}\pi + 2800\pi$			M1 for a complete method (Award M4 for 8133.3…….. if $\frac{24\,400}{3}$ is not seen)
		$\frac{24\,400}{3}$		A1 $8133.\dot{3}$ or $8133\frac{1}{3}$ (as exact form was requested) SC B4 for an answer of 25551(.62….) if no method shown
				Total 5 marks

Q	Working	Answer	Mark	Notes
23	$[DN=]8\sin 30$ **or** $8\cos 60$ $(=4)$ oe [where N is the midpoint of EC] **or** $[x=]8\cos 30$ **or** $8\sin 60 (=4\sqrt{3}=6.928...)$ **or** $2x=\sqrt{8^2+8^2-2\times 8\times 8\times\cos 120}(=\sqrt{192}=8\sqrt{3}=13.85....)$		5	M1
	$[DN=]8\sin 30$ **or** $8\cos 60$ $(=4)$ oe eg $\sqrt{8^2-(4\sqrt{3})^2}(=4)$ **And 1 of** $[x=]8\cos 30$ **or** $8\sin 60 (=4\sqrt{3}=6.928...)$ oe or $\sqrt{8^2-"4"^2}(=4\sqrt{3}=6.928...)$ **or** $2x=\sqrt{8^2+8^2-2\times 8\times 8\times\cos 120}(=8\sqrt{3}=13.85....)$			M1 $[(JM=)\ 4+4\sqrt{3}$ implies M2]
	$[AM=]\sqrt{12^2+("4\sqrt{3}")^2}$ $(=\sqrt{192}=8\sqrt{3}=13.856\ldots)$ oe [where M is the midpoint of GH]			M1 **Clear intention to be *AM* (not *EC*)**
	$\tan MAJ=\left(\frac{"4"+"4\sqrt{3}"}{"8\sqrt{3}"}\right)$ oe eg $\tan MAJ=\left(\frac{10.928...}{13.856...}\right)$ if student uses sin or cos, then $AJ=17.647\ldots$ to award marks this must come from a correct method or be correct			M1
	Correct answer scores full marks (unless from obvious incorrect working)	38.3		A1 Accept 38.1 – 38.4 If no marks scored then award SCB2 for $\tan MAJ=\frac{4+x}{\sqrt{x^2+12^2}}$ or SCB1 for $AM=\sqrt{x^2+12^2}$
				Total 5 marks

23	$(39 \div 3)^2 + 39^2$ **or** $1521 + 169$ $(= 1690)$		5	M1	for summing the area of the 2 squares – may be seen embedded in a calculation
	$\sqrt{45^2 + (39 \div 2)^2}$ $(= 49.043...)$ **or** $\sqrt{15^2 + \left(\frac{39 \div 3}{2}\right)^2}$ $(= 16.347...)$ oe			M1	for finding the perpendicular slant height of either pyramid M2 for eg $\sqrt{\left(\frac{39-13}{2}\right)^2 + (45-15)^2}$ $(= \sqrt{1069} = 32.695...)$
	$\frac{2}{3} \times$"49.043..." **or** $2 \times$"16.347..." $(= 32.695...)$ oe **OR** $\frac{1}{2} \times 13 \times$"16.347..."$(= 106.260...)$ **or** $4 \times \frac{1}{2} \times 13 \times$"16.347..."$(= 425.042...)$ **or** $\frac{1}{2} \times 39 \times$"49.043..."$(= 956.345...)$ **or** $4 \times \frac{1}{2} \times 39 \times$"49.043..."$(= 3825.381...)$			M1	for finding the perpendicular slant height of the frustum **OR** the area of 1 or 4 triangular faces for either pyramid
	$(39 \div 3)^2 + 39^2 + 4 \times \frac{(39 \div 3) + 39}{2} \times$"32.695..." **OR** $(39 \div 3)^2 + 39^2 +$ "3825.381..." – "425.042..."			M1	correct calculation for total surface area
	Correct answer scores full marks (unless from obvious incorrect working)	5090		A1	accept 5090 – 5091
					Total 5 marks

21	$(FE=)28\sin 30(=14)$ **or** $(FE=)28\cos 60(=14)$ **or** $(DE=)28\cos 30\left(=14\sqrt{3}=24.2(48...)\right)$ **or** $(DE=)28\sin 60\left(=14\sqrt{3}=24.2(48...)\right)$		5	M1 for a method to find *FE* **or** *DE*
	$(FE=)28\sin 30(=14)$ **or** $(FE=)28\cos 60(=14)$ **or** $(FE=)\sqrt{28^2-"24.2..."^2}\left(=\sqrt{196}=14\right)$ **and** $(DE=)28\cos 30\left(=14\sqrt{3}=24.2(48...)\right)$ **or** $(DE=)28\sin 60\left(=14\sqrt{3}=24.2(48...)\right)$ **or** $(DE=)\sqrt{28^2-"14"^2}\left(=\sqrt{588}=14\sqrt{3}=24.2(48...)\right)$			M1 for a method to find *FE* **and** *DE* (can now use their *FE* or *DE* found for first M1)
	$(AF=)\sqrt{53^2-28^2}\left(=\sqrt{2809-784}=\sqrt{2025}=45\right)$			M1 (indep) for finding *AF*
	$\frac{1}{2}\times"14"\times"14\sqrt{3}"\times"45"$ oe or $\frac{1}{2}\times"14"\times"24.2"\times"45"$			M1 for finding the volume of the prism
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	7638		A1 allow in the range 7623 – 7639
				Total 5 marks

Question	Working	Answer	Mark	Notes
23	$V=\frac{1}{3}\pi\times6^2\times15(=180\pi=565.48...)$		5	M1 a correct expression for volume of large cone
	$\frac{6}{15}=\frac{x}{\text{height}}$ or height $=\frac{15}{6}x=\frac{5}{2}x$ oe used or (vol sml cone =) $\left(\frac{x}{6}\right)^3 V$ or $\left(\frac{x}{6}\right)^3\times180\pi$ or (vol sml cone ="180π"$-\frac{4212}{25}\pi\left(=\frac{288}{25}\pi=11.52\pi=36.19...\right)$			M1 working with the scale factor (where V = vol of large cone) **or** formula for volume of sml cone, (ft their vol of large cone dep on a correct method) (NB: $\frac{4212}{25}=168.48$, $\frac{4212}{25}\pi=529.29...$)
	eg $\frac{1}{3}\pi\times x^2\times\frac{5}{2}x$ $(=\frac{5}{6}\pi x^3)$ oe or linear SF $=\sqrt[3]{\frac{180\pi}{\frac{288}{25}\pi}}(=2.5)$ oe or $\sqrt[3]{\frac{288/25}{180}}(=0.4)$ oe ***2.5 and 0.4 must be from correct working seen to award the mark (not from height/radius)***			M1 dep on previous M1 correct formula for volume of small cone in terms of x only, could be seen as part of an equation and π could be cancelled out **or** Correct calculation for linear SF of v to V
	eg $\frac{1}{3}\times\pi\times6^2\times15-\frac{1}{3}\times\pi\times x^2\times\frac{5}{2}x=\frac{4212}{25}\pi$ **or** $180-\frac{5}{6}x^3=\frac{4212}{25}$oe **or** $\left[1-\left(\frac{x}{6}\right)^3\right]180\pi=\frac{4212}{25}\pi$ oe **or** $x=\frac{6}{2.5}$ **or** $h=\frac{15}{2.5}=6$ **and** $\frac{1}{3}\pi x^2 6=\frac{288}{25}\pi(=11.52\pi)$			M1 dep on M3 A correct equation in x (if using 2.5 this must come from a correct method)
	Working required	2.4		A1oe dep on M3
				Total 5 marks

23	$\frac{1}{3}\pi\times(5x)^2\times 6x$ oe or $50\pi x^3$ oe or $\frac{1}{2}\times\frac{4}{3}\times\pi\times(2x)^3$ or $\frac{16}{3}\pi x^3$ oe or $\frac{4}{3}\times\pi\times(2x)^3$ or $\frac{32}{3}\pi x^3$ oe		5	M1 for finding the volume of cone or hemisphere or sphere NB Ignore missing brackets around $5x$ and $2x$ for this mark
	$\frac{1}{3}\pi\times(5x)^2\times 6x-\frac{1}{2}\times\frac{4}{3}\times\pi\times(2x)^3=6948\pi$ oe or $50\pi x^3-\frac{16}{3}\pi x^3=6948\pi$ or $\frac{134}{3}\pi x^3=6948\pi$ oe			M1 for a **correct** equation for the volume of the shape NB If not expanded at this stage then must see brackets
	$\left(x^3=\right)\frac{6948\pi\times 3}{134\pi}\left(=\frac{10422}{67}=155.(552...)\right)$ oe or $\left(x=\right)\sqrt[3]{\frac{6948\pi\times 3}{134\pi}}\left(=\sqrt[3]{\frac{10422}{67}}=\sqrt[3]{155.(552...)}=5.37(8...)\right)$ oe			M1 for rearranging the **correct** equation to find the value of x^3 or x Accept 5.4 or better
	$3\times\pi\times(2\times"5.37(8...)")^2$ oe or $12\times\pi\times$ "$5.37(8..)$"^{2} oe			M1 for finding the surface area of the hemisphere
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	1090		A1 allow 1086 – 1100 Special case for using 6948 without π SC B3 for $x^3 = 49.5(138\ldots)$ or $x = 3.67(205\ldots)$ SC B4 for awrt 508
				Total 5 marks

23 (i)		(6, 7)	1	B1	
(ii)		(2, −3)	1	B1	
				Total 2 marks	

24 (a)	eg $\frac{1}{3}\times\pi\times x^2\times 3x\left(=\pi x^3\right)$ oe **or** $\frac{1}{2}\times\frac{4}{3}\times\pi\times x^3\left(=\frac{4}{6}\pi x^3=\frac{2}{3}\pi x^3\right)$ oe **or** $\frac{4}{3}\times\pi\times(kx)^3$ oe		4	M1	for an expression for the volume of the cone **or** the hemisphere **or** the sphere NB Ignore missing brackets around kx for this mark Allow r for x for all M marks
	eg $\frac{4}{3}\times\pi\times(kx)^3=12.5\times\left(\frac{1}{2}\times\frac{4}{3}\pi x^3+\frac{1}{3}\pi x^2(3x)\right)$ oe **or** $\frac{4}{3}\times\pi\times(kx)^3=12.5\left(\frac{2}{3}\pi x^3+\pi x^3\right)$ oe **or** $\frac{4}{3}\times\pi\times(kx)^3=12.5\times\frac{5}{3}\pi x^3$ oe **or** $\frac{4}{3}\times\pi\times(kx)^3=\frac{125}{6}\pi x^3$ oe			M1	for a **correct** equation for the volumes NB If $(kx)^3$ not expanded at this stage then must see brackets
	eg $\left(k^3=\right)\frac{\frac{125}{6}\pi}{\frac{4}{3}\pi}$ oe **or** $\left(k^3=\right)\frac{125}{8}$ oe **or** $\left(k=\right)\sqrt[3]{\frac{125}{8}}$ oe $k^3x^3=\frac{12.5\times\frac{5}{3}\pi x^3}{\frac{4}{3}\pi}$ oe **or** $kx=\frac{\sqrt[3]{12.5\times\frac{5}{3}\pi x^3}}{\sqrt[3]{\frac{4}{3}\pi}}$ **or** $kx=\sqrt[3]{\frac{125x^3}{8}}$ oe			M1	for a **correct** calculation for k or k^3 or for a **correct** equation for kx or k^3x^3
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	2.5		A1	oe
(b)		64	1	B1	
				Total 5 marks	

26	eg $\frac{1}{2} \times \frac{4}{3}\pi x^3 = 6174\pi$		5	M1	oe for forming a correct equation; allow use of any letter	
	$(x =) \sqrt[3]{\frac{6174\pi \times 3}{2\pi}}$ $(= \sqrt[3]{9261} = 21)$			M1	for a correct method to find the radius of the hemisphere	
	eg $\pi([21])^2 - \pi([21] - 2)^2$ $(= 441\pi - 361\pi = 80\pi)$ oe **or** $2\pi([21])^2 + 2\pi([21] - 2)^2$ $(= 882\pi + 722\pi = 1604\pi)$ oe			M1ft	for a method to find the area of the top of the bowl **or** the total area of the two curved surfaces of the bowl where [21] is what they believe to be radius of the hemisphere	M2 for use of formula for total surface area of hemispherical shell in a complete method, eg $3\pi([21])^2 + \pi([21] - 2)^2$ oe If not M2, allow M1 for this formula used with omission of π eg $3([21])^2 + ([21] - 2)^2$
	"1604π"+"80π"			M1ft	ft their [21] for a complete method	
	Correct answer only scores full marks (unless from obviously incorrect working)	1684π		A1	cao SCB4 for 2028π (use of 23 as the outer radius)	
						Total 5 marks

Question	Working	Answer	Mark	Notes	
22	$\frac{\pi r^2}{\pi r^2 + \pi rl} = \frac{3}{8}$ **or** $\pi r^2 : \pi r^2 + \pi rl = 3:8$ **or**			M1	
	$\pi r^2 : \pi rl = 3:5$ **or** $\pi r^2 = 3$ **and** $\pi rl = 5$				
	$8\pi r^2 = 3(\pi r^2 + \pi rl)$ **or** $5\pi r^2 = 3\pi rl$ **or**			M1	
	$[r = \sqrt{\frac{3}{\pi}}\ (= 0.9772...)$ **and** $l = \frac{5}{\pi r}]$				
	$\frac{r}{l} = \frac{3}{5}$ oe **or** $l = \frac{5}{\pi\sqrt{\frac{3}{\pi}}}\ (= 1.62...)$			M1	
	e.g. $\sin\left(\frac{AVB}{2}\right) = \frac{3}{5}$ oe eg $\sin\left(\frac{AVB}{2}\right) = \frac{\sqrt{3/\pi}}{\pi\sqrt{3/\pi}}$			M1	$\sin^{-1}(\frac{3}{5}) = 36.86....$
	$2 \times \sin^{-1}\left(\frac{3}{5}\right)$ oe			M1	
		73.7	6	A1	awrt

26	$1600 = \frac{1}{3} \times \pi \times r^2 \times 25$ oe		6	M1 for substituting into volume formula for cone correctly and equating to 1600
	eg $r = \sqrt{\frac{1600}{\frac{1}{3} \pi \times 25}}$ or $r = \sqrt{\frac{192}{\pi}} (= \sqrt{61.1(154..)} = 7.8176...)$			M1 dep for correct rearrangement of volume formula for r
	$l = \sqrt{"7.817..."^2 + 25^2} (= \sqrt{686.1154...} = 26.193...)$			M1 Dep on M2 correct method to find slant height of cone (radius of sector)
	$2 \times \pi \times$ "7.817…" (= 49.1196…) **or** $\pi \times "7.817..." \times "26.193..." (= 643.315...)$			M1 for using $C = 2\pi r$ oe using figures from correct method **or** for using $A = \pi rl$ using figures from correct method
	$"49.1196..." = 2 \times \pi \times "26.193..." \times \frac{x}{360}$ **or** $"643.315..." = \pi \times "26.193..."^2 \times \frac{x}{360}$			M1 for using arc length = $2\pi r \times \frac{x}{360}$ **or** for using area of sector = $\pi r^2 \times \frac{x}{360}$
		107°		A1 for 107° - 108°
				Total 6 marks

22	eg $\frac{4}{3}\pi r^3 = 288\pi$ oe $\frac{4}{3}\pi\left(\frac{x}{2}\right)^3 = 288\pi$ oe		6	M1 for using the formula for the volume of a sphere correctly and equating it to 288π
	$x = 12$			A1
	$\sqrt{(5\times'12')^2+(0.5\times'12')^2}(=6\sqrt{101}=60.299...)$ oe **or** $(OC=)0.5\sqrt{'24'^2+'12'^2}(=6\sqrt{5})$ **and** $AC=\sqrt{'(6\sqrt{5})'^2+'60'^2}(=6\sqrt{105})$ **and** $\sqrt{'(6\sqrt{105})'^2-'12'^2}(=6\sqrt{101})$ oe			M1 (dep on first M1 and using their value for x) for using Pythagoras to find the perp height of faces *CAD* or *BAE* or a correct method to find angle *CAD* or *BAE*
	$\sqrt{(5\times'12')^2+(1\times'12')^2}(=12\sqrt{26}=61.188...))$oe **or** $(OC=)0.5\sqrt{'24'^2+'12'^2}(=6\sqrt{5})$ **and** $AC=\sqrt{'(6\sqrt{5})'^2+'60'^2}(=6\sqrt{105})$ **and** $\sqrt{'(6\sqrt{105})'^2-'6'^2}(=12\sqrt{26})$ oe			M1 (dep on first M1 and using their value for x) for using Pythagoras to find the perp height of faces *ABC* or *AED* or a correct method to find angle *BAC* or *DAE*
	('12' × 2('12')) + 2(0.5 × '12' × '$12\sqrt{26}$') +2(0.5 × 2'12' × '$6\sqrt{101}$') oe eg $'288'+2\times'72\sqrt{26}'+2\times'72\sqrt{101}'$ or '288' + 2 × '367.129'…+ 2 × '723.59…' oe			M1 (dep on first M1 using their value for x and correct working for heights of each triangle)for working out the total surface area of the pyramid
	Correct answer scores full marks (unless from obvious incorrect working)	2469		A1 2469 - 2470
				Total 6 marks

21	$\pi x^2 + 2\pi x \times 3x + \frac{1}{2} \times 4\pi x^2 = 81\pi$ oe or $9x^2 = 81$oe **or** $2\pi x \times 3x + \frac{1}{2} \times 4\pi x^2 = 81\pi$ oe or $8x^2 = 81$		6	M1 for setting up an equation (in a single variable ie x or r) for the total surface area of the shape **or** for the curved surface area.
	$(x =) \sqrt{\frac{81}{9}} (= 3)$			M1 solving their equation in the form $kx^2\pi = 81\pi$ (where k follows correctly from their surface area) to find x
	$\pi \times '3'^2 \times 3 \times '3' + \frac{1}{2} \times \frac{4}{3} \pi '3'^3$ oe $(= 81\pi + 18\pi = 99\pi = 311.(017\ldots))$			M1 (indep) for substituting their value of x to find the volume of the shape.
	99π or 311.(017…)			A1
	$\frac{840}{'311'}$ (= 2.7….) oe			M1 (dep on the 3rd M) for using the formula for density
		aluminium		A1 for aluminium **and** correct working leading to 2.7
				Total 6 marks

24	eg $\frac{4}{3}\pi r^3 \div 2 (= \frac{2}{3}\pi r^3)$ oe		6	M1 for finding the volume of hemisphere
	eg $\frac{1}{3}\pi(kr)^2 kh \ - \ \frac{1}{3}\pi r^2 h (= \frac{1}{3}\pi r^2 h(k^3 - 1))$ oe			M1 for finding the volume of the frustum
	eg $\frac{1}{3}\pi r^2 h(k^3 - 1) + \frac{2}{3}\pi r^3$ **or** $\frac{1}{3}\pi r^2 h + \frac{2}{3}\pi r^3$ oe			M1 for a correct expression for the volume of Solid **A or** Solid **B**
	eg $\frac{1}{3}\pi r^2 h(k^3 - 1) + \frac{2}{3}\pi r^3 = 6\left(\frac{1}{3}\pi r^2 h + \frac{2}{3}\pi r^3\right)$ oe			M1 for a correct equation using the volumes of Solid **A** and Solid **B** (π could be cancelled out)
	eg $h(k^3 - 1) - 6h = 12r - 2r$ oe			M1 for simplifying to a point where the h terms are on one side of an equation and other terms the other side – must be correct
	NB: note that simplest form was not required	$\frac{10r}{k^3 - 7}$		A1 oe eg $\frac{4r - \frac{2}{3}r}{\frac{1}{3}k^3 - 2\frac{1}{3}}$
				Total 6 marks

24	eg $k \times \frac{1}{3}\pi r^2 h = \frac{4}{3}\pi r^3$ **or** $k \times \frac{1}{3}\pi r^2 h = \frac{4}{3}\pi r^3$ **or** $k \times \frac{1}{3}\pi r^2 h = \frac{4}{3}\pi r^3$ **or** $k \times h = 4r$		6	M1	for setting up an equation with volumes and some simplification (minimum of 2 terms simplified)
	$h = \frac{4r}{k}$			M1	for finding h in terms of r and k in its simplest form (may be seen at a later stage)
	eg $l^2 = r^2 + \left(\frac{4r}{k}\right)^2$ **or** $l = \sqrt{r^2 + \left(\frac{4r}{k}\right)^2}$			M1	for correct substitution into Pythagoras' theorem (accept substitution of $h = \frac{4\pi r}{\pi k}$)
	eg $l = r\sqrt{1 + \frac{16}{k^2}}$ **or** $l = r\sqrt{\frac{k^2+16}{k^2}}$ **or** $l = r\frac{\sqrt{k^2+16}}{k}$			M1	for rearranging and removing the r from the square root (may be seen at a later stage)
	eg $\pi r^2\left(\sqrt{1 + \frac{16}{k^2}} + 1\right)$			M1	for a correct expression for surface area in terms of r and k with πr^2 removed as a factor
	Correct answer scores full marks (unless from obvious incorrect working)	$\pi r^2\left(\frac{k + \sqrt{k^2+16}}{k}\right)$		A1	
					Total 6 marks

7	(a)		1	1	B1 cao
	(b)		-6	1	B1 Allow 3^{-6}
					Total 2 marks

8	(a)	$-4x > 17 - 9$ or $-4x > 8$ or $9 - 17 > 4x$ or $-8 > 4x$ or $\frac{9}{4} - x > \frac{17}{4}$ oe or $-\frac{9}{4} + x < -\frac{17}{4}$ oe		2	M1 for a correct first step Condone = rather than > or any other sign for this mark.
		Correct answer scores full marks (unless from obvious incorrect working)	$x < -2$		A1 oe eg $-2 > x$ (sight of correct answer in working space and just (x =) –2 on answer line gains M1 only)
	(b)		$y \geq 2$ $x \leq 6$ $y \leq x$	3	B3 for all 3 correct Allow $2 \leq y, 6 \geq x$ and $x \geq y$ B2 for 2 correct B1 for 1 correct Allow < and > signs SCB2: $y \leq 2$, $y \geq x$ and $x \geq 6$ (for all 3) Allow < and > signs
		Correct answer scores full marks (unless from obvious incorrect working)			**Total 5 marks**

9	$\sin 32 = \frac{(BC)}{50}$ or $\cos 32 = \frac{(CD)}{50}$ or $\frac{(BC)}{\sin 32} = \frac{50}{\sin 90}$ oe or $\frac{(CD)}{\sin(90-32)} = \frac{50}{\sin 90}$ oe		6	M1
	$(BC =) 50\sin 32 (= 26.4(959...))$ or $(BC =) \sqrt{50^2 - (50\cos 32)^2} (= 26.4(959...))$ or $(BC =) \sqrt{50^2 - "42.4..."^2} (= 26.4(998...))$ or $(BC =) \frac{50}{\sin 90} \times \sin 32$ oe			M1 for finding *BC* or *AD* Can be written on the diagram
	$(CD =) 50\cos 32 (= 42.4(024)\ldots)$ or $(CD =) \sqrt{50^2 - (50\sin 32)^2} (= 42.4(024...))$ or $(CD =) \sqrt{50^2 - "26.4..."^2} (= 42.4(622...))$ or $(CD =) \frac{50}{\sin 90} \times \sin(90-32)$			M1 for finding *CD* or *BA* Can be written on the diagram
	$(r =)$"42.4(024…)" ÷ 2π (= 6.74(855…))			M1 for finding the radius of the cylinder
	$(V =) \pi \times$ "6.74(855…)"$^2 \times$ "26.4(959…)"			M1 dep on previous M mark for the use of $\pi r^2 h$
	Correct answer scores full marks (unless from obvious incorrect working)	3790		A1 allow answers in the range 3737 – 3794 Accept answers in standard form
				Total 6 marks