Mathematics

Paper 4

Geometry
Mensuration
Trigonometry

QUESTIONS

3 **(a)** Manjeet uses 220 litres of water each day.
She reduces the amount of water she uses by 15%.

Calculate the number of litres of water she now uses each day.

..... litres [2]

(b) Manjeet has two mathematically similar bottles in her bathroom.
The large bottle holds 1.35 litres and is 29.7 cm high.
The small bottle holds 0.4 litres.

Calculate the height of the small bottle.

..... cm [3]

(c) Water from Manjeet's shower flows at a rate of 12 litres per minute.
The water from the shower flows into a tank that is a cuboid of length 90 cm and width 75 cm.

Calculate the increase in the level of water in the tank when the shower is used for 7 minutes.

..... cm [3]

4 A solid metal cone has radius 1.65 cm and slant height 4.70 cm.

(a) Calculate the **total** surface area of the cone.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

..... cm^2 [2]

(b) Find the angle the slant height makes with the base of the cone.

..... [2]

(c) **(i)** Calculate the volume of the cone.
[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

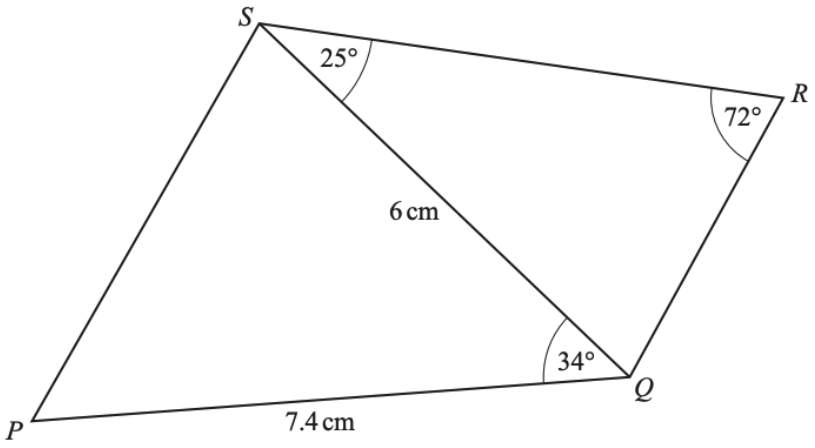
..... cm^3 [4]

(ii) A metal sphere with radius 5 cm is melted down to make cones identical to this one.

Calculate the number of complete identical cones that are made.
[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... [4]

8 (a)



NOT TO SCALE

The diagram shows a quadrilateral *PQRS* formed from two triangles, *PQS* and *QRS*.

Calculate

(i) *QR*,

QR = ... cm [3]

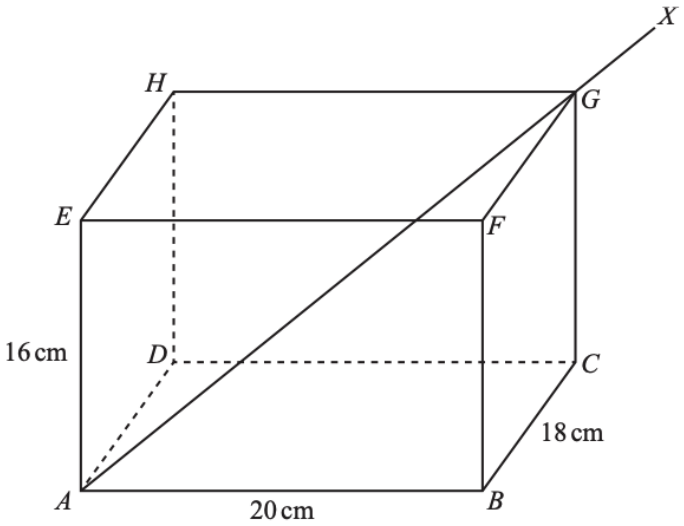
(ii) *PS*,

PS = ... cm [3]

(iii) the area of quadrilateral *PQRS*.

..... cm^2 [4]

(b)



NOT TO SCALE

The diagram shows an open box $ABCDEFGH$ in the shape of a cuboid.
$AB = 20$ cm, $BC = 18$ cm and $AE = 16$ cm.
A thin rod AGX rests partly in the box as shown.
The rod is 40 cm long.

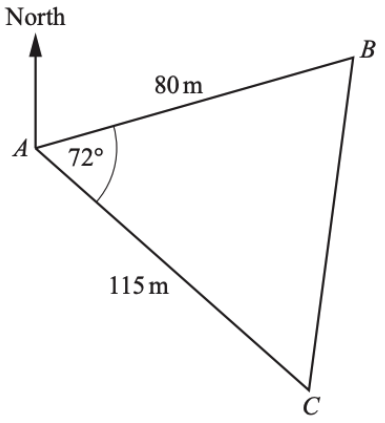
(i) Calculate GX, the length of the rod which is outside the box.

$GX =$ ..... cm [4]

(ii) Calculate the angle the rod makes with the base of the box.

..... [3]

7



NOT TO SCALE

The diagram shows the positions of three points A, B and C in a field.

(a) Show that BC is 118.1 m, correct to 1 decimal place.

[3]

(b) Calculate angle ABC.

Angle ABC = ... [3]

(c) The bearing of C from A is 147°.

Find the bearing of

(i) A from B,

..... [3]

(ii) B from C.

..... [2]

(d) Mitchell takes 35 seconds to run from A to C.

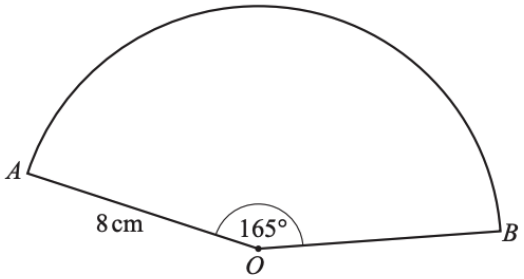
Calculate his average running speed in kilometres per hour.

..... km/h [3]

(e) Calculate the shortest distance from point B to AC.

..... m [3]

9



NOT TO SCALE

The diagram shows a sector of a circle with centre O, radius 8 cm and sector angle 165°.

(a) Calculate the total perimeter of the sector.

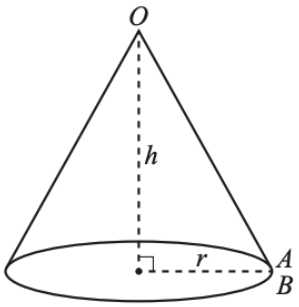
..... cm [3]

(b) The surface area of a sphere is the same as the area of the sector.

Calculate the radius of the sphere.
[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

..... cm [4]

(c)



NOT TO SCALE

A cone is made from the sector by joining OA to OB.

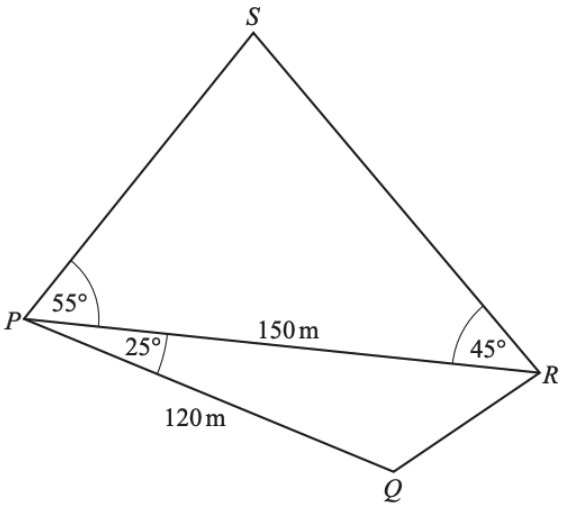
(i) Calculate the radius, r, of the cone.

$r =$ ..... cm [2]

(ii) Calculate the volume of the cone.
[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

..... cm^3 [4]

4



NOT TO SCALE

The diagram shows two triangles.

(a) Calculate QR.

$QR =$ ..... m [3]

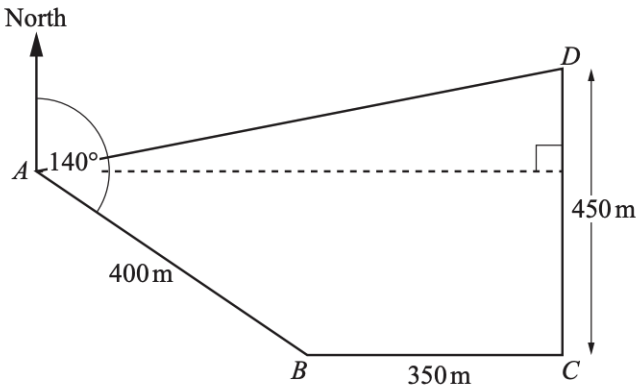
(b) Calculate RS.

$RS =$ ..... m [4]

(c) Calculate the total area of the two triangles.

..... m^2 [3]

5



NOT TO SCALE

The diagram shows a field $ABCD$.
The bearing of B from A is 140°.
C is due east of B and D is due north of C.
$AB = 400$ m, $BC = 350$ m and $CD = 450$ m.

(a) Find the bearing of D from B.

..... [2]

(b) Calculate the distance from D to A.

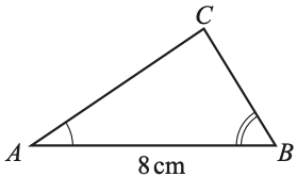
..... m [6]

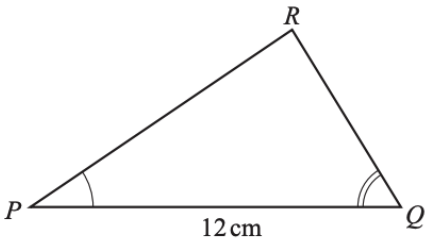
(c) Jono runs around the field from A to B, B to C, C to D and D to A.
He runs at a speed of 3 m/s.

Calculate the total time Jono takes to run around the field.
Give your answer in minutes and seconds, correct to the nearest second.

..... min ..... s [4]

8 (a)





NOT TO SCALE

Triangle ABC is mathematically similar to triangle PQR.
The area of triangle ABC is $16\,cm^2$.

(i) Calculate the area of triangle PQR.

..... cm^2 [2]

(ii) The triangles are the cross-sections of prisms which are also mathematically similar.
The volume of the smaller prism is $320\,cm^3$.

Calculate the length of the larger prism.

..... cm [3]

(b) A cylinder with radius 6 cm and height h cm has the same volume as a sphere with radius 4.5 cm.

Find the value of h.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

$h =$ ..... [3]

(c) A solid metal cube of side 20 cm is melted down and made into 40 solid spheres, each of radius r cm.

Find the value of r.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

$r =$ ..... [3]

(d) A solid cylinder has radius x cm and height $\frac{7x}{2}$ cm.

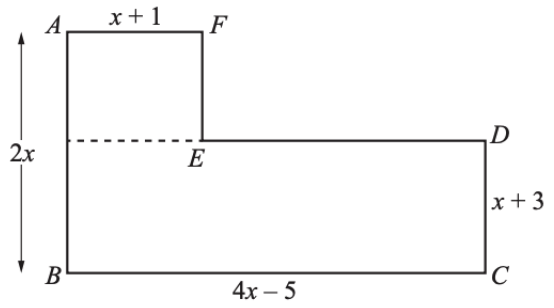
The surface area of a sphere with radius R cm is equal to the total surface area of the cylinder.

Find an expression for R in terms of x.

[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

$R =$ ..... [3]

5 All the lengths in this question are in centimetres.



NOT TO SCALE

The diagram shows a shape *ABCDEF* made from two rectangles.
The total area of the shape is 342 cm^2.

(a) Show that $x^2 + x - 72 = 0$.

[5]

(b) Solve by factorisation.

$$x^2 + x - 72 = 0$$

$x =$ ..... or $x =$ ..... [3]

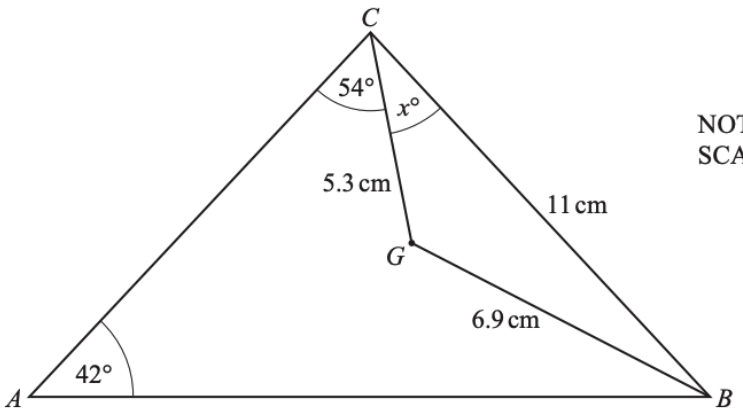
(c) Work out the perimeter of the shape *ABCDEF*.

..... cm [2]

(d) Calculate angle *DBC*.

Angle *DBC* = ... [2]

6 (a)



NOT TO SCALE

The diagram shows triangle ABC with point G inside.
$CB = 11$ cm, $CG = 5.3$ cm and $BG = 6.9$ cm.
Angle $CAB = 42°$ and angle $ACG = 54°$.

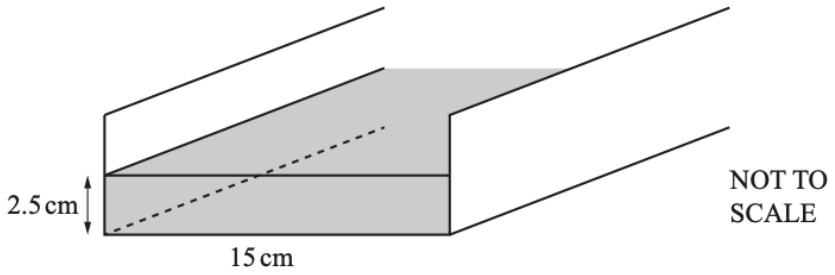
(i) Calculate the value of x.

$x =$ ..... [4]

(ii) Calculate AC.

$AC =$ ..... cm [4]

(b)



Water flows at a speed of 20 cm/s along a rectangular channel into a lake.
The width of the channel is 15 cm.
The depth of the water is 2.5 cm.

Calculate the amount of water that flows from the channel into the lake in 1 hour.
Give your answer in litres.

..... litres [4]

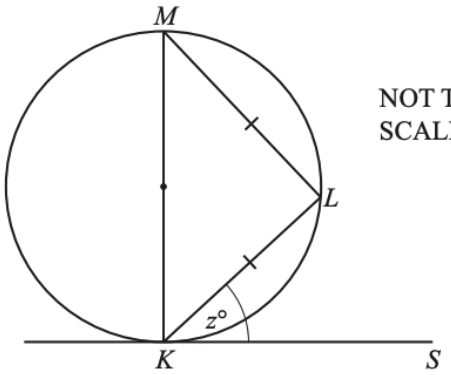
8 **(a)** The interior angle of a regular polygon with n sides is 150°.

Calculate the value of n.

$n =$ ..... [2]

(b) **(i)** K, L and M are points on the circle.
KS is a tangent to the circle at K.
KM is a diameter and
triangle KLM is isosceles.

Find the value of z.

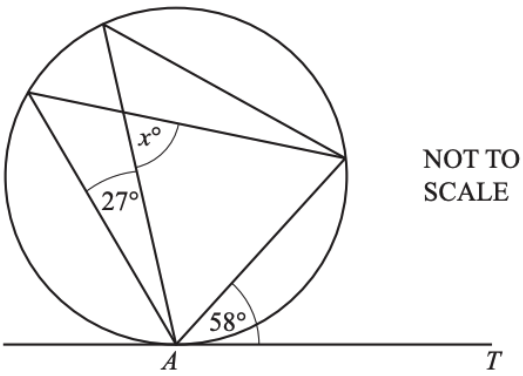


NOT TO SCALE

$z =$ ..... [2]

(ii) AT is a tangent to the circle at A.

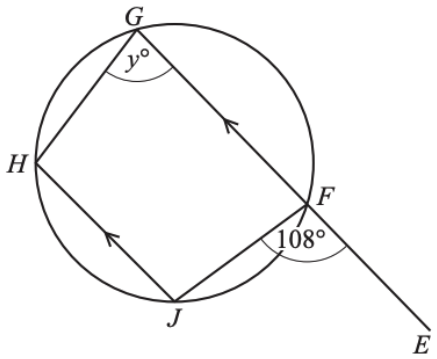
Find the value of x.



NOT TO SCALE

$x =$ ..... [2]

(iii)



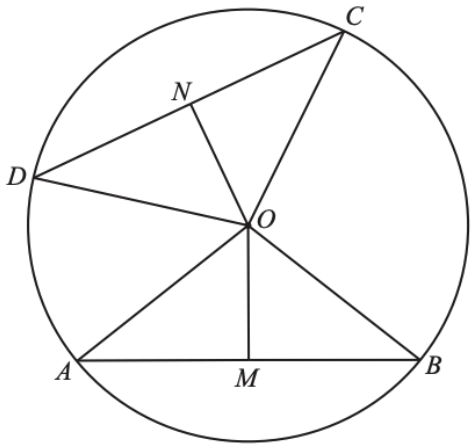
NOT TO SCALE

F, *G*, *H* and *J* are points on the circle.
EFG is a straight line parallel to *JH*.

Find the value of *y*.

y = ... [2]

(c)



NOT TO SCALE

A, *B*, *C* and *D* are points on the circle, centre *O*.
M is the midpoint of *AB* and *N* is the midpoint of *CD*.
OM = *ON*

Explain, giving reasons, why triangle *OAB* is congruent to triangle *OCD*.

.....

.....

.....

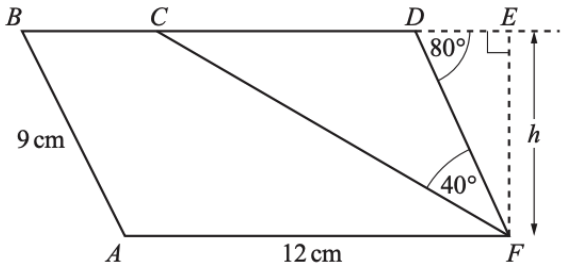
..... [3]

4 **(a)** A rectangle measures 8.5 cm by 10.7 cm, both correct to 1 decimal place.

Calculate the upper bound of the perimeter of the rectangle.

..... cm [3]

(b)



NOT TO SCALE

ABDF is a parallelogram and *BCDE* is a straight line.
AF = 12 cm, *AB* = 9 cm, angle *CFD* = 40° and angle *FDE* = 80°.

(i) Calculate the height, *h*, of the parallelogram.

h = ... cm [2]

(ii) Explain why triangle *CDF* is isosceles.

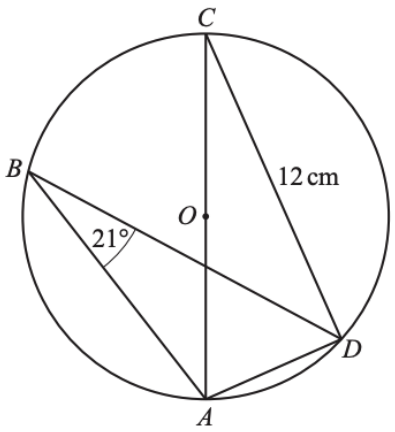
.....

..... [2]

(iii) Calculate the area of the **trapezium** *ABCF*.

..... cm^2 [3]

(c)



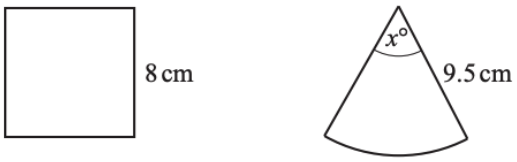
NOT TO SCALE

A, B, C and D are points on the circle, centre O.
Angle $ABD = 21°$ and $CD = 12$ cm.

Calculate the area of the circle.

..... cm^2 [5]

(d)



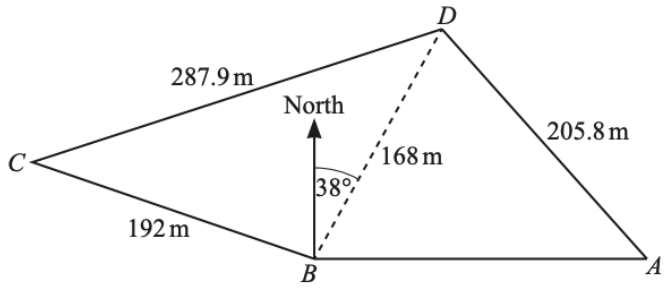
NOT TO SCALE

The diagram shows a square with side length 8 cm and a sector of a circle with radius 9.5 cm and sector angle $x°$.
The perimeter of the square is equal to the perimeter of the sector.

Calculate the value of x.

$x =$ ..... [3]

6



The diagram shows a field, *ABCD*, on horizontal ground.
$BC = 192$ m, $CD = 287.9$ m, $BD = 168$ m and $AD = 205.8$ m.

(a) (i) Calculate angle *CBD* and show that it rounds to 106.0°, correct to 1 decimal place.

[4]

(ii) The bearing of *D* from *B* is 038°.

Find the bearing of *C* from *B*.

..... [1]

(iii) *A* is **due east** of *B*.

Calculate the bearing of *D* from *A*.

..... [5]

(b) (i) Calculate the area of triangle *BCD*.

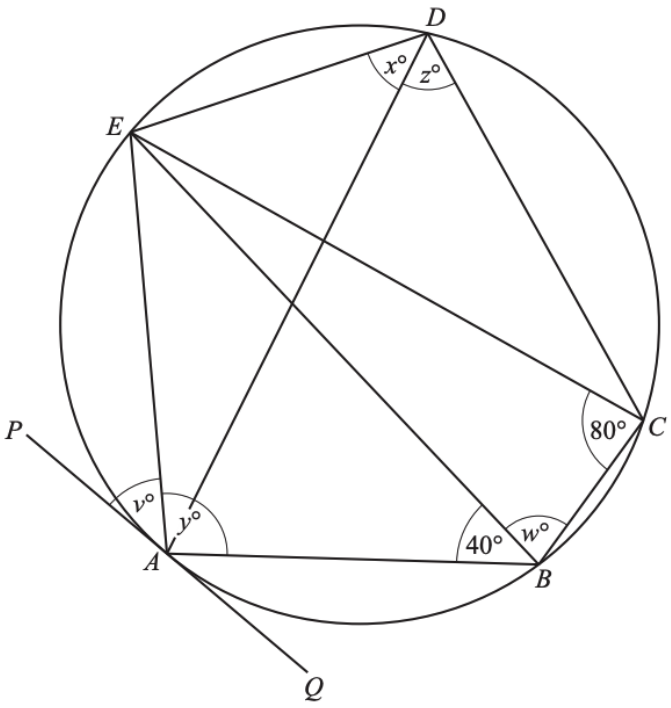
..... m^2 [2]

(ii) Tomas buys the triangular part of the field, *BCD*.
The cost is \$35 750 per hectare.

Calculate the amount he pays.
Give your answer correct to the nearest \$100.
[1 hectare = 10 000 m^2]

\$ ..... [2]

8 (a)

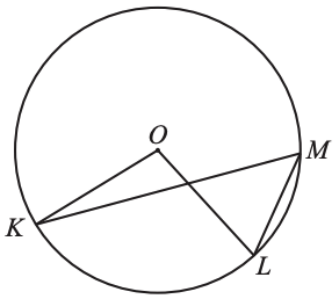


The points A, B, C, D and E lie on the circle.
PAQ is a tangent to the circle at A and $EC = EB$.
Angle $ECB = 80°$ and angle $ABE = 40°$.

Find the values of v, w, x, y and z.

$v =$ ..... $w =$ ..... $x =$ ..... $y =$ ..... $z =$ ..... [5]

(b)



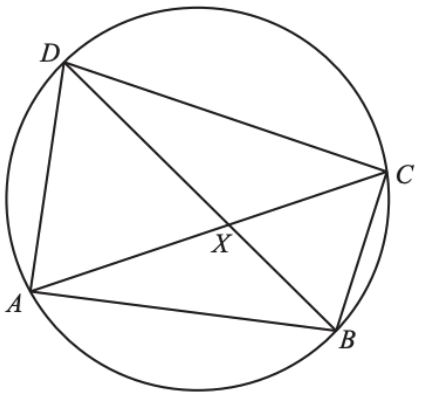
NOT TO
SCALE

In the diagram, K, L and M lie on the circle, centre O.
Angle $KML = 2x°$ and reflex angle $KOL = 11x°$.

Find the value of x.

$x =$ ..... [3]

(c)



NOT TO SCALE

The diagonals of the cyclic quadrilateral $ABCD$ intersect at X.

(i) Explain why triangle ADX is similar to triangle BCX.
Give a reason for each statement you make.

.....

.....

.....

..... [3]

(ii) $AD = 10\,\text{cm}$, $BC = 8\,\text{cm}$, $BX = 5\,\text{cm}$ and $CX = 7\,\text{cm}$.

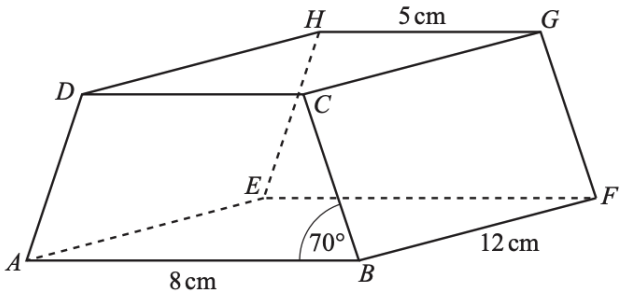
(a) Calculate DX.

$DX =$ ..... cm [2]

(b) Calculate angle BXC.

Angle $BXC =$ ..... [4]

9



NOT TO SCALE

The diagram shows a prism with a rectangular base, *ABFE*.
The cross-section, *ABCD*, is a trapezium with $AD = BC$.
$AB = 8$ cm, $GH = 5$ cm, $BF = 12$ cm and angle $ABC = 70°$.

(a) Calculate the total surface area of the prism.

..... cm^2 [6]

(b) The perpendicular from G onto EF meets EF at X.

(i) Show that $EX = 6.5$ cm.

[1]

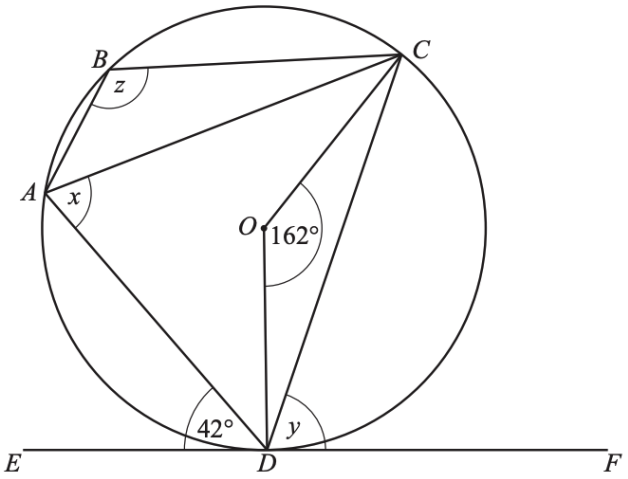
(ii) Calculate AX.

$AX =$ ..... cm [2]

(iii) Calculate the angle between the diagonal AG and the base $ABFE$.

..... [2]

5 (a)



NOT TO SCALE

A, B, C and D are points on the circle, centre O.
EF is a tangent to the circle at D.
Angle $ADE = 42°$ and angle $COD = 162°$.

Find the following angles, giving reasons for each of your answers.

(i) Angle x

$x =$ ..... because .....

..... [2]

(ii) Angle y

$y =$ ..... because .....

..... [2]

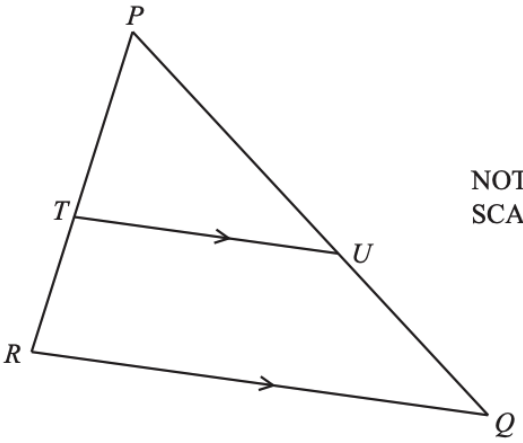
(iii) Angle z

$z =$ ..... because .....

.....

..... [3]

(b)



NOT TO SCALE

PQR is a triangle.
T is a point on PR and U is a point on PQ.
RQ is parallel to TU.

(i) Explain why triangle PQR is similar to triangle PUT.
Give a reason for each statement you make.

.....

.....

.....

..... [3]

(ii) $PT : TR = 4 : 3$

(a) Find the ratio $PU : PQ$.

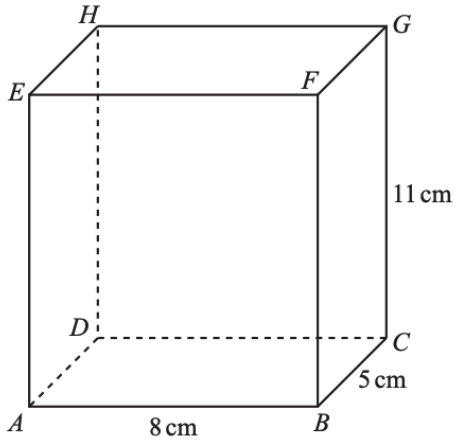
..... : ..... [1]

(b) The area of triangle PUT is $20\,cm^2$.

Find the area of the quadrilateral $QRTU$.

..... cm^2 [3]

6



NOT TO SCALE

ABCDEFGH is a cuboid.
$AB = 8$ cm, $BC = 5$ cm and $CG = 11$ cm.

(a) Work out the volume of the cuboid.

..... cm^3 [2]

(b) Ivana has a pencil of length 13 cm.

Does this pencil fit completely inside the cuboid?
Show how you decide.

[4]

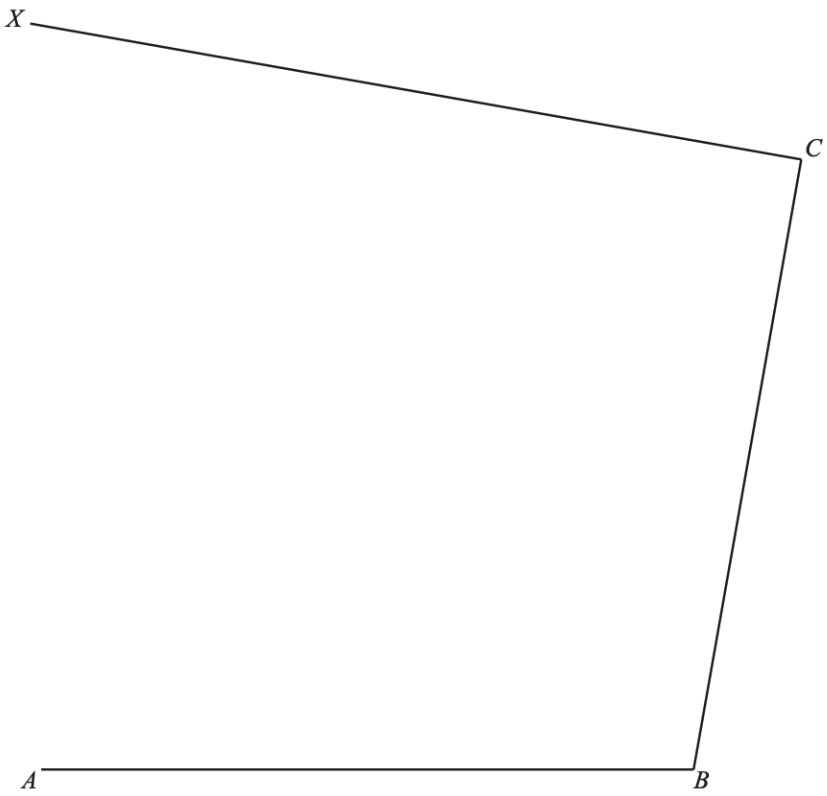
(c) **(i)** Calculate angle *CAB*.

Angle *CAB* = ... [2]

(ii) Calculate angle *GAC*.

Angle *GAC* = ... [2]

4 The diagram shows an incomplete scale drawing of a market place, $ABCD$, where D is on CX.
The scale is 1 centimetre represents 5 metres.



Scale : 1 cm to 5 m

D lies on CX such that angle $DAB = 75°$.

(a) On the diagram, draw the line AD and mark the position of D. [2]

(b) Find the actual length of the side BC of the market place.

..... m [2]

(c) In this part, use a ruler and compasses only.

Street sellers are allowed in the part of the market place that is

- more than 35 metres from A

and

- nearer to C than to B

and

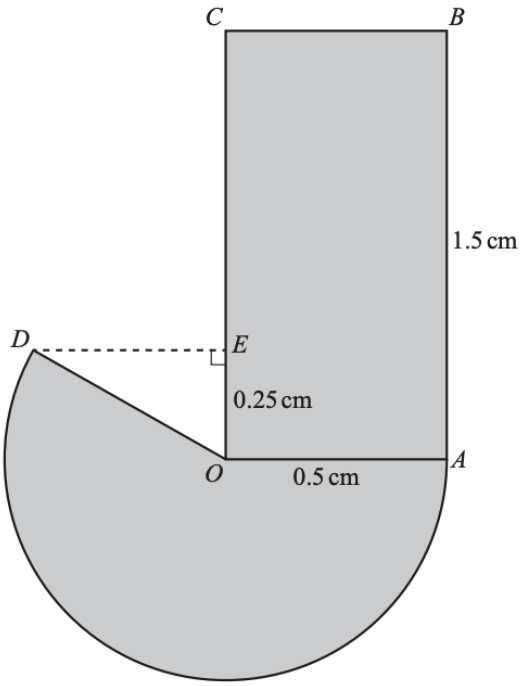
- nearer to CD than to BC.

On the diagram, construct and shade the region where street sellers are allowed. [7]

(d) Write the scale of the drawing in the form $1 : n$.

1 : ..... [1]

6



NOT TO SCALE

The diagram shows a company logo made from a rectangle and a major sector of a circle.
The circle has centre O and radius OA.
$OA = OD = 0.5$ cm and $AB = 1.5$ cm.
E is a point on OC such that $OE = 0.25$ cm and angle $OED = 90°$.

(a) Calculate the perimeter of the logo.

..... cm [5]

(b) Calculate the area of the logo.

..... cm^2 [3]

(c) A mathematically similar logo is drawn.
The area of this logo is 77.44 cm^2.

(i) Calculate the radius of the major sector in this logo.

..... cm [3]

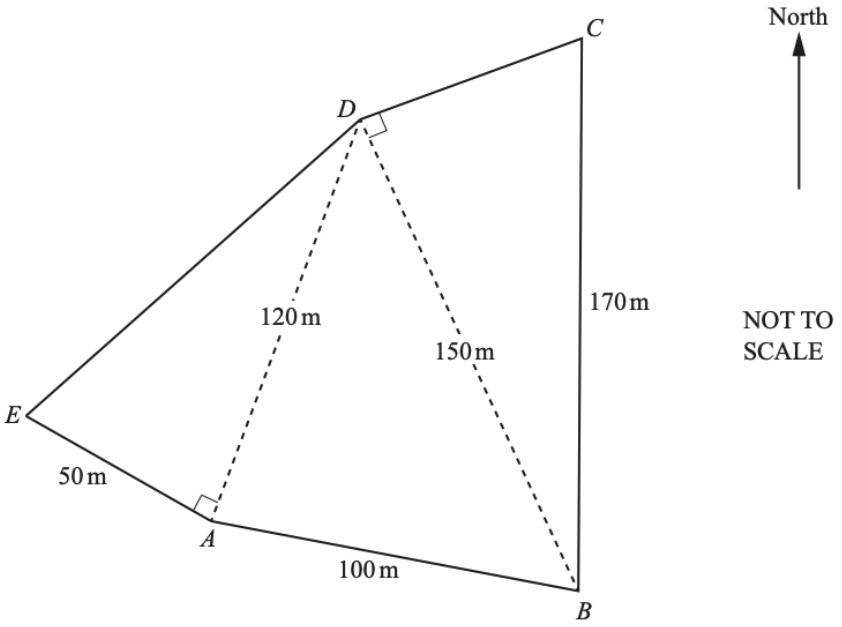
(ii) A gold model is made.
This model is a prism with a cross-section of area 77.44 cm^2.

This gold model is 15 mm thick.
One cubic centimetre of gold has a mass of 19 grams.

Calculate the mass of the gold model in kilograms.

..... kg [3]

3



The diagram shows a field *ABCDE*.

(a) Calculate the perimeter of the field *ABCDE*.

..... m [4]

(b) Calculate angle *ABD*.

Angle *ABD* = ... [4]

(c) **(i)** Calculate angle *CBD*.

Angle *CBD* = ... [2]

(ii) The point *C* is due north of the point *B*.

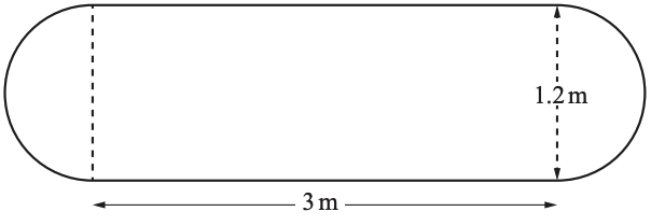
Find the bearing of *D* from *B*.

..... [2]

(d) Calculate the area of the field *ABCDE*.
Give your answer in hectares.
[1 hectare = 10 000 m^2]

..... hectares [4]

5



NOT TO SCALE

The diagram shows the surface of a garden pond, made from a rectangle and two semicircles.
The rectangle measures 3 m by 1.2 m.

(a) Calculate the area of this surface.

..... m^2 [3]

(b) The pond is a prism and the water in the pond has a depth of 20 cm.

Calculate the number of litres of water in the pond.

..... litres [3]

(c) After a rainfall, the number of litres of water in the pond is 1007.

Calculate the increase in the depth of water in the pond.
Give your answer in centimetres.

..... cm [3]

10 The volume of each of the following solids is $1000\,\text{cm}^3$.

Calculate the value of x for each solid.

(a) A cube with side length x cm.

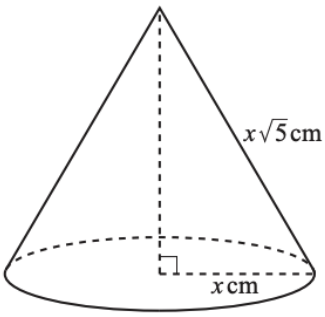
$x =$ ..... [1]

(b) A sphere with radius x cm.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

$x =$ ..... [3]

(c)



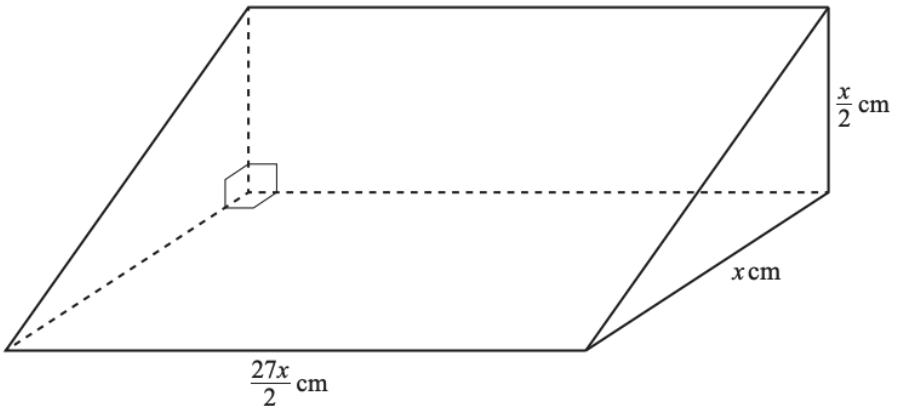
NOT TO SCALE

A cone with radius x cm and slant height $x\sqrt{5}$ cm.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

$x =$ ..... [4]

(d)

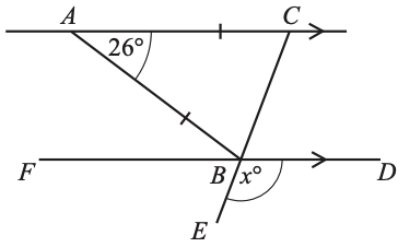


NOT TO SCALE

A prism with a right-angled triangle as its cross-section.

$x =$ ..... [4]

2 **(a)**



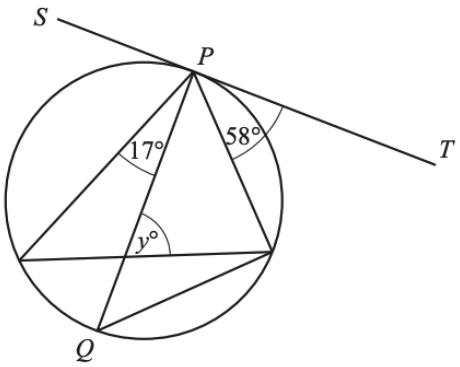
NOT TO SCALE

AC is parallel to *FBD*, *ABC* is an isosceles triangle and *CBE* is a straight line.

Find the value of x.

$x =$ ..... [3]

(b)



NOT TO SCALE

The diagram shows a circle with diameter *PQ*.
SPT is a tangent to the circle at *P*.

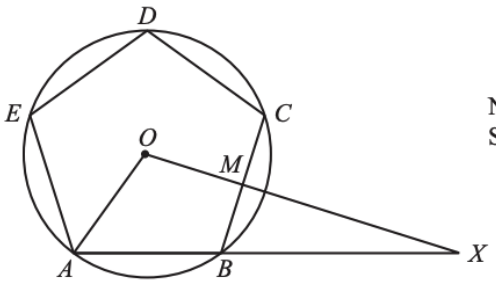
Find the value of y.

$y =$ ..... [5]

7 **(a)** Show that each interior angle of a regular pentagon is 108°.

[2]

(b)



NOT TO SCALE

The diagram shows a regular pentagon *ABCDE*.
The vertices of the pentagon lie on a circle, centre *O*, radius 12 cm.
M is the midpoint of *BC*.

(i) Find *BM*.

BM = ... cm [3]

(ii) *OMX* and *ABX* are straight lines.

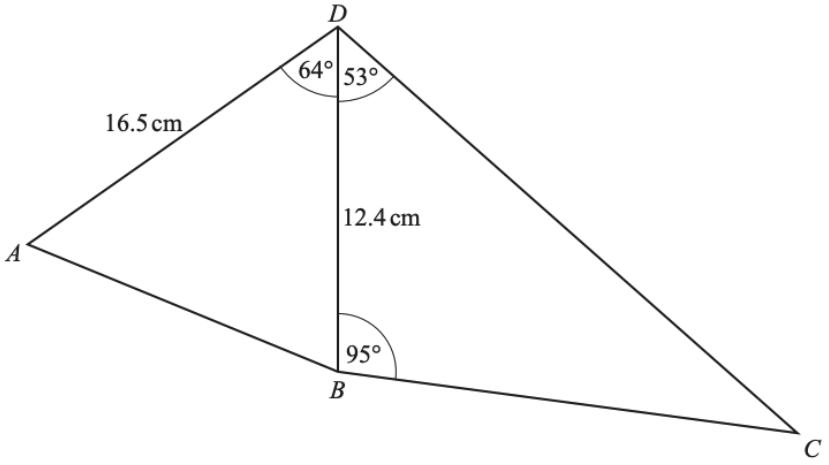
(a) Find *BX*.

BX = ... cm [3]

(b) Calculate the area of triangle *AOX*.

..... cm^2 [3]

8 (a)



NOT TO SCALE

The diagram shows two triangles ABD and BCD.
$AD = 16.5$ cm and $BD = 12.4$ cm.
Angle $ADB = 64°$, angle $BDC = 53°$ and angle $DBC = 95°$.

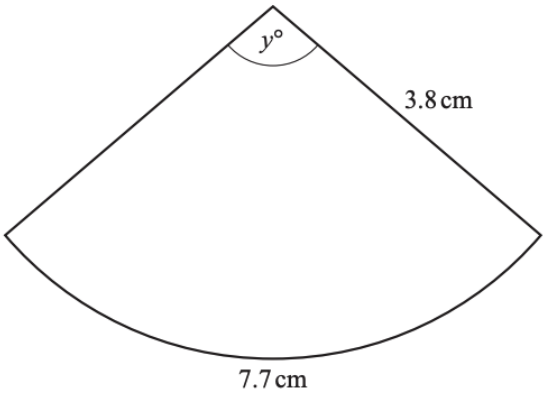
(i) Find AB.

$AB =$ ..... cm [4]

(ii) Find BC.

$BC =$ ..... cm [4]

(b)



NOT TO SCALE

The diagram shows a sector of a circle of radius 3.8 cm.
The arc length is 7.7 cm.

(i) Calculate the value of y.

$y =$ ..... [2]

(ii) Calculate the area of the sector.

..... cm^2 [2]

10 **(a)** The volume of a solid metal sphere is $24\,430\,\text{cm}^3$.

(i) Calculate the radius of the sphere.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... cm [3]

(ii) The metal sphere is placed in an empty tank.
The tank is a cylinder with radius 50 cm, standing on its circular base.
Water is poured into the tank to a depth of 60 cm.

Calculate the number of litres of water needed.

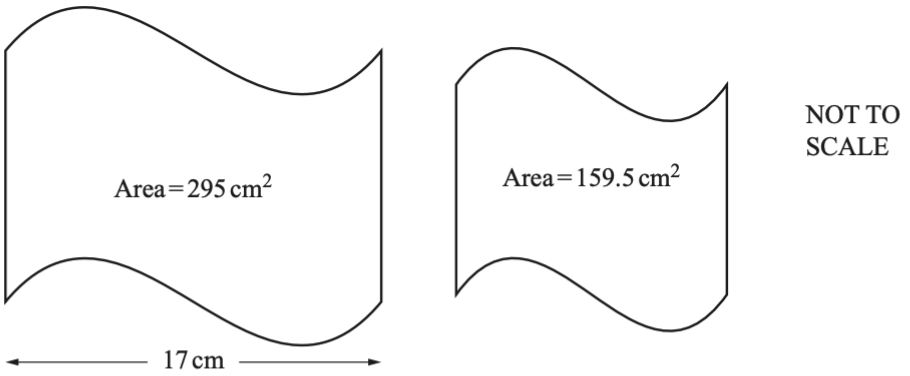
..... litres [3]

(b) A different tank is a cuboid measuring 1.8 m by 1.5 m by 1.2 m.
Water flows from a pipe into this empty tank at a rate of $200\,\text{cm}^3$ per second.

Find the time it takes to fill the tank.
Give your answer in hours and minutes.

..... hours ..... minutes [4]

(c)



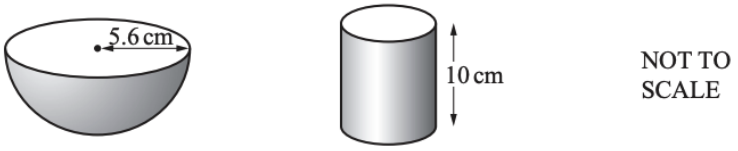
NOT TO SCALE

The diagram shows two mathematically similar shapes with areas 295 cm^2 and 159.5 cm^2.
The width of the larger shape is 17 cm.

Calculate the width of the smaller shape.

..... cm [3]

4 **(a)**



The diagram shows a hemispherical bowl of radius 5.6 cm and a cylindrical tin of height 10 cm.

(i) Show that the volume of the bowl is 368 cm^3, correct to the nearest cm^3.
[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

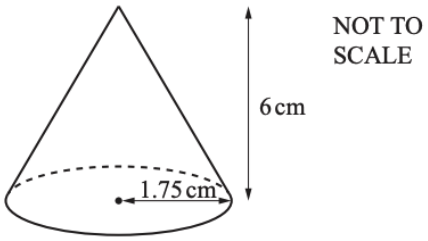
[2]

(ii) The tin is completely full of soup.
When all the soup is poured into the empty bowl, 80% of the volume of the bowl is filled.

Calculate the radius of the tin.

..... cm [4]

(b)

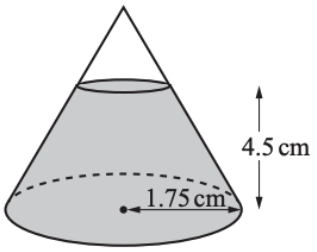


The diagram shows a cone with radius 1.75 cm and height 6 cm.

(i) Calculate the total surface area of the cone.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

..... cm^2 [5]

(ii)



NOT TO SCALE

The cone contains salt to a depth of 4.5 cm.
The top layer of the salt forms a circle that is parallel to the base of the cone.

(a) Show that the volume of the salt inside the cone is 18.9 cm^3, correct to 1 decimal place.
[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

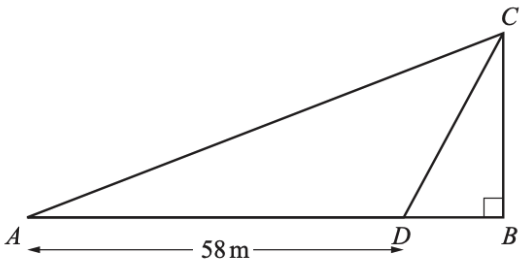
[4]

(b) The salt is removed from the cone at a constant rate of 200 mm^3 per second.

Calculate the time taken for the cone to be completely emptied.
Give your answer in seconds, correct to the nearest second.

..... s [3]

9 (a)



NOT TO SCALE

In the diagram, BC is a vertical wall standing on horizontal ground AB.
D is the point on AB where $AD = 58$ m.
The angle of elevation of C from A is 26°.
The angle of elevation of C from D is 72°.

(i) Show that $AC = 76.7$ m, correct to 1 decimal place.

[5]

(ii) Calculate BD.

$BD =$ ..... m [3]

(b) Triangle EFG has an area of $70\,m^2$.
$EF : FG = 1 : 2$ and angle $EFG = 40°$.

(i) Calculate EF.

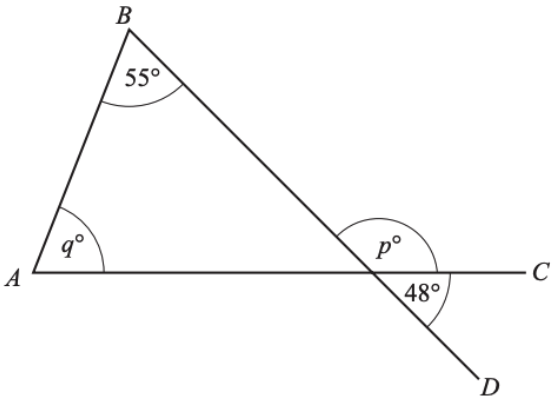
$EF =$ ..... m [4]

(ii) A **different** triangle PQR also has an area of $70\,m^2$.
$PQ : QR = 1 : 2$ and $PQ = EF$.

Find angle PQR.

Angle $PQR =$ ..... [1]

1 **(a)**



NOT TO SCALE

In the diagram, AC and BD are straight lines.

Find the value of p and the value of q.

$p =$ .....

$q =$ ..... [3]

(b) The angles of a quadrilateral are $x°$, $(x+5)°$, $(2x-25)°$ and $(x+10)°$.

Find the value of x.

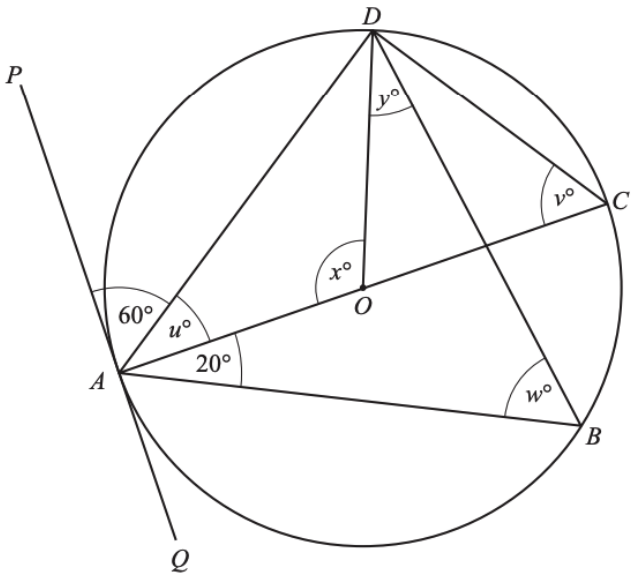
$x =$ ..... [3]

(c) A regular polygon has 72 sides.

Find the size of an interior angle.

..... [3]

(d)



NOT TO SCALE

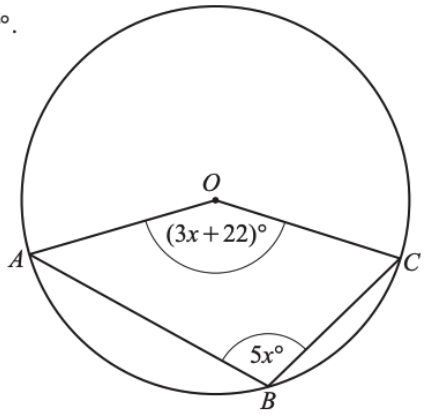
A, B, C and D lie on the circle, centre O, with diameter AC.
PQ is a tangent to the circle at A.
Angle $PAD = 60°$ and angle $BAC = 20°$.

Find the values of u, v, w, x and y.

$u =$ ....., $v =$ ....., $w =$ ....., $x =$ ....., $y =$ ..... [6]

(e) A, B and C lie on the circle, centre O.
Angle $AOC = (3x+22)°$ and angle $ABC = 5x°$.

Find the value of x.



NOT TO SCALE

$x =$ ..... [4]

4 **(a)** **(i)** Calculate the **external curved** surface area of a cylinder with radius 8 m and height 19 m.

..... m^2 [2]

(ii) This surface is painted at a cost of \$0.85 per square metre.

Calculate the cost of painting this surface.

\$ ..... [2]

(b) A solid metal sphere with radius 6 cm is melted down and all of the metal is used to make a solid cone with radius 8 cm and height h cm.

(i) Show that $h = 13.5$.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

[2]

(ii) Calculate the slant height of the cone.

..... cm [2]

(iii) Calculate the curved surface area of the cone.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi r l$.]

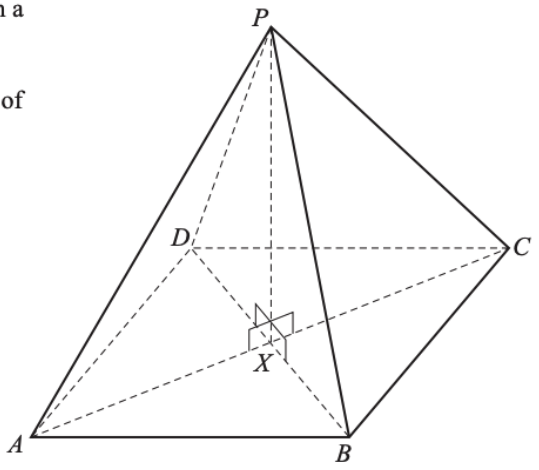
..... cm^2 [1]

(c) Two cones are mathematically similar.
The total surface area of the smaller cone is $80\,cm^2$.
The total surface area of the larger cone is $180\,cm^2$.
The volume of the smaller cone is $168\,cm^3$.

Calculate the volume of the larger cone.

..... cm^3 [3]

(d) The diagram shows a pyramid with a square base $ABCD$.
$DB = 8\,cm$.
P is vertically above the centre, X, of the base and $PX = 5\,cm$.

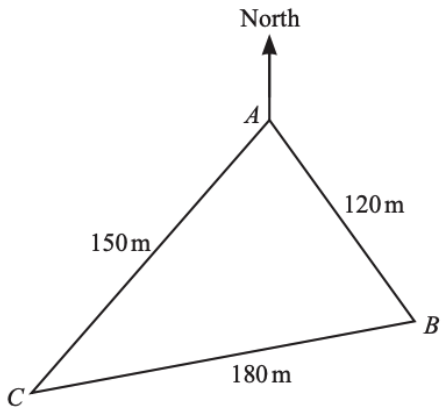


NOT TO SCALE

Calculate the angle between PB and the base $ABCD$.

..... [3]

5



NOT TO SCALE

The diagram shows a triangular field, ABC, on horizontal ground.

(a) Olav runs from A to B at a constant speed of 4 m/s and then from B to C at a constant speed of 3 m/s. He then runs at a constant speed from C to A.
His average speed for the whole journey is 3.6 m/s.

Calculate his speed when he runs from C to A.

..... m/s [3]

(b) Use the cosine rule to find angle BAC.

Angle BAC = ... [4]

(c) The bearing of C from A is 210°.

(i) Find the bearing of B from A.

..... [1]

(ii) Find the bearing of A from B.

..... [2]

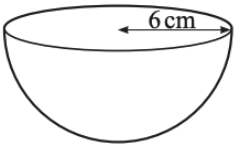
(d) D is the point on AC that is nearest to B.

Calculate the distance from D to A.

..... m [2]

4 **(a)**

NOT TO SCALE



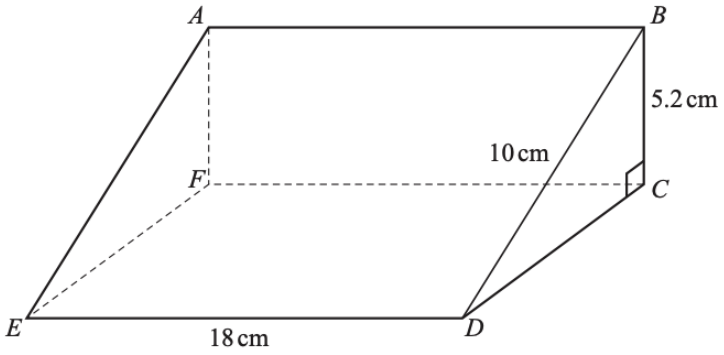
The diagram shows a hemisphere with radius 6 cm.

Calculate the volume.
Give the units of your answer.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

.... [3]

(b)



NOT TO SCALE

The diagram shows a prism $ABCDEF$.
The cross-section is a right-angled triangle BCD.
$BD = 10$ cm, $BC = 5.2$ cm and $ED = 18$ cm.

(i) **(a)** Work out the volume of the prism.

..... cm^3 [6]

(b) Calculate angle *BEC*.

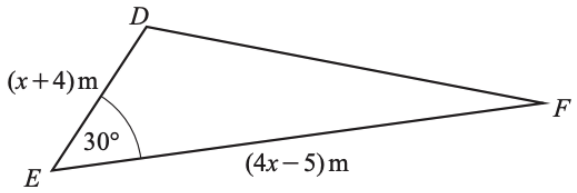
Angle *BEC* = ... [4]

(ii) The point *G* lies on the line *ED* and *GD* = 7 cm.

Work out angle *BGE*.

Angle *BGE* = ... [3]

(b)



NOT TO SCALE

The area of triangle DEF is $70\,m^2$.

(i) Show that $4x^2 + 11x - 300 = 0$.

[4]

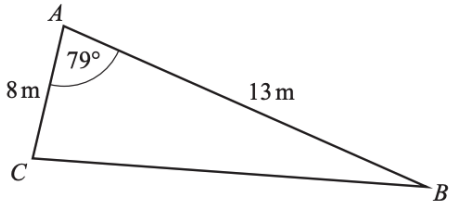
(ii) Use the quadratic formula to solve $4x^2 + 11x - 300 = 0$.
Show all your working and give your answers correct to 2 decimal places.

$x =$ ..... or $x =$ ..... [4]

(iii) Find the length of DE.

$DE =$ ..... m [1]

6 (a)



NOT TO SCALE

The diagram shows triangle ABC.

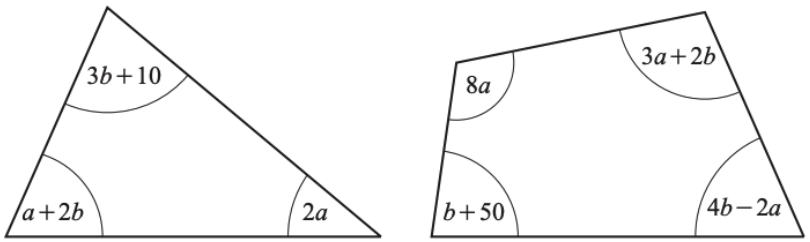
(i) Use the cosine rule to calculate BC.

$BC =$ ..... m [4]

(ii) Use the sine rule to calculate angle ACB.

Angle $ACB =$ ..... [3]

2 **(a)** The diagram shows a triangle and a quadrilateral.
All angles are in degrees.



NOT TO SCALE

(i) For the triangle, show that $3a+5b=170$.

[1]

(ii) For the quadrilateral, show that $9a+7b=310$.

[1]

(iii) Solve these simultaneous equations.
Show all your working.

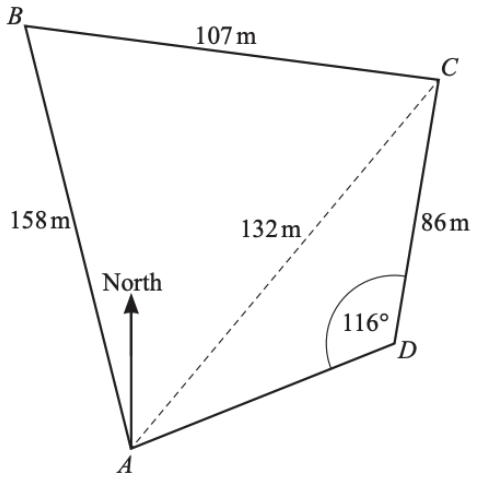
$a =$ .....

$b =$ ..... [3]

(iv) Find the size of the smallest angle in the triangle.

..... [1]

4



NOT TO SCALE

The diagram shows a field, *ABCD*, on horizontal ground.

(a) There is a vertical post at *C*.
From *B*, the angle of elevation of the top of the post is 19°.

Find the height of the post.

..... m [2]

(b) Use the cosine rule to find angle *BAC*.

Angle *BAC* = ... [4]

(c) Use the sine rule to find angle CAD.

Angle CAD = ... [3]

(d) Calculate the area of the field.

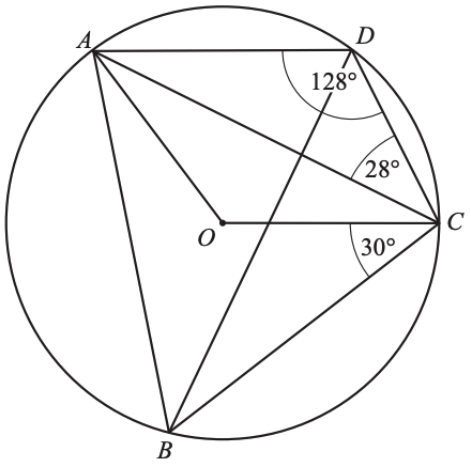
..... m^2 [3]

(e) The bearing of D from A is 070°.

Find the bearing of A from C.

..... [2]

6 (a)



NOT TO SCALE

In the diagram, A, B, C and D lie on the circle, centre O.
Angle $ADC = 128°$, angle $ACD = 28°$ and angle $BCO = 30°$.

(i) Show that obtuse angle $AOC = 104°$.
Give a reason for each step of your working.

[3]

(ii) Find angle BAO.

Angle $BAO =$ ..... [2]

(iii) Find angle ABD.

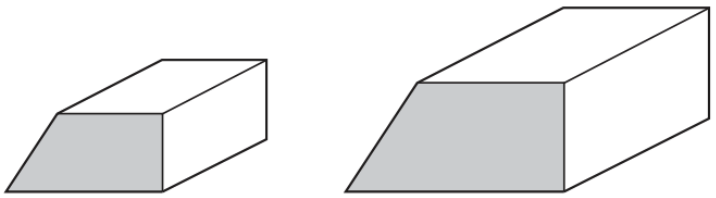
Angle $ABD =$ ..... [1]

(iv) The radius, OC, of the circle is 9.6 cm.

Calculate the total perimeter of the sector $OADC$.

..... cm [3]

(b)



NOT TO SCALE

The diagram shows two mathematically similar solid metal prisms.
The volume of the smaller prism is 648 cm^3 and the volume of the larger prism is 2187 cm^3.
The area of the cross-section of the smaller prism is 36 cm^2.

(i) Calculate the area of the cross-section of the larger prism.

..... cm^2 [3]

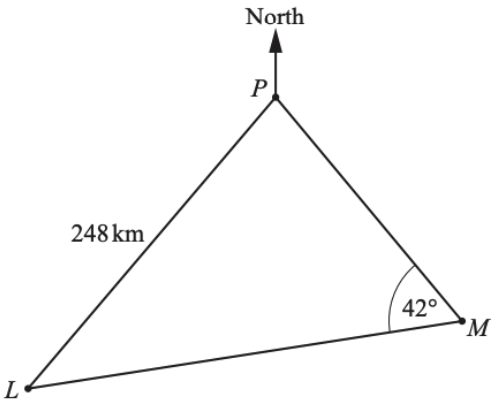
(ii) The larger prism is melted down into a sphere.

Calculate the radius of the sphere.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... cm [3]

8



NOT TO SCALE

The diagram shows two ports, L and P, and a buoy, M.
The bearing of L from P is 201° and $LP = 248$ km.
The bearing of M from P is 127°.
Angle $PML = 42°$.

(a) Use the sine rule to calculate LM.

$LM =$ ..... km [4]

(b) A ship sails directly from L to P.

(i) Calculate the shortest distance from M to LP.

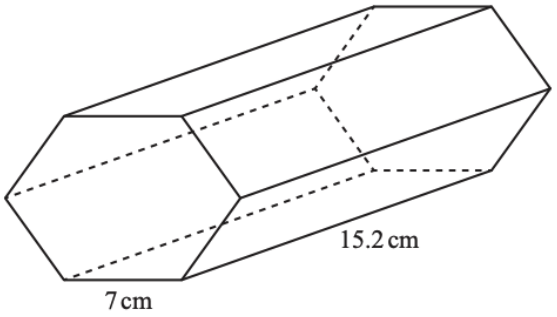
..... km [3]

(ii) The ship leaves L at 2045 and travels at a speed of 40 km/h.

Calculate the time the next day that the ship arrives at P.

..... [3]

5 **(a)**



NOT TO SCALE

The diagram shows a solid prism with length 15.2 cm.
The cross-section of this prism is a **regular** hexagon with side 7 cm.

(i) Calculate the volume of the prism.

..... cm^3 [5]

(ii) Calculate the total surface area of the prism.

..... cm^2 [3]

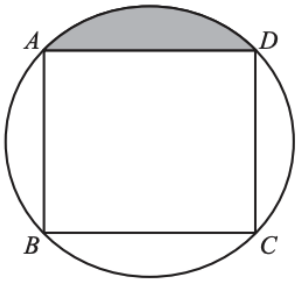
(b) Another solid metal prism with volume 500 cm^3 is melted and made into 6 identical spheres.

Calculate the radius of each sphere.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... cm [3]

2



NOT TO SCALE

The vertices of a square *ABCD* lie on the circumference of a circle, radius 8 cm.

(a) Calculate the area of the square.

..... cm^2 [2]

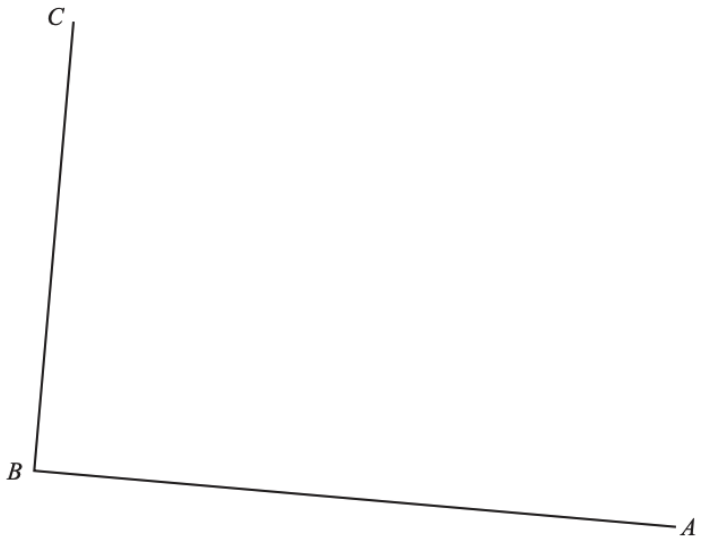
(b) **(i)** Calculate the area of the shaded segment.

..... cm^2 [3]

(ii) Calculate the perimeter of the shaded segment.

..... cm [4]

2 The scale drawing shows two boundaries, *AB* and *BC*, of a field *ABCD*.
The scale of the drawing is 1 cm represents 8 m.



Scale: 1 cm to 8 m

(a) The boundaries *CD* and *AD* of the field are each 72 m long.

(i) Work out the length of *CD* and *AD* on the scale drawing.

..... cm [1]

(ii) **Using a ruler and compasses only**, complete accurately the scale drawing of the field. [2]

(b) A tree in the field is

- equidistant from *A* and *B*

and

- equidistant from *AB* and *BC*.

On the scale drawing, construct two lines to find the position of the tree.
Use a straight edge and compasses only and leave in your construction arcs. [4]

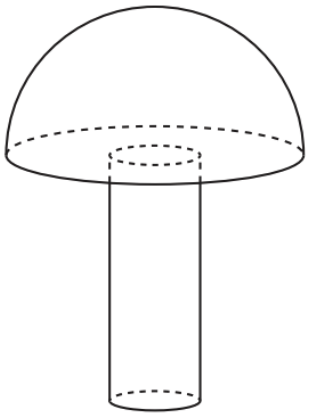
6 A solid hemisphere has volume $230\,\text{cm}^3$.

(a) Calculate the radius of the hemisphere.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... cm [3]

(b) A solid cylinder with radius 1.6 cm is attached to the hemisphere to make a toy.



NOT TO SCALE

The total volume of the toy is $300\,\text{cm}^3$.

(i) Calculate the height of the cylinder.

..... cm [3]

(ii) A mathematically similar toy has volume 19 200 cm^3.

Calculate the radius of the cylinder for this toy.

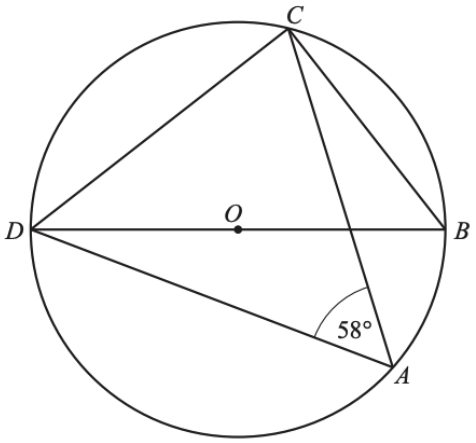
..... cm [3]

8 **(a)** The exterior angle of a regular polygon is $x°$ and the interior angle is $8x°$.

Calculate the number of sides of the polygon.

..... [3]

(b)



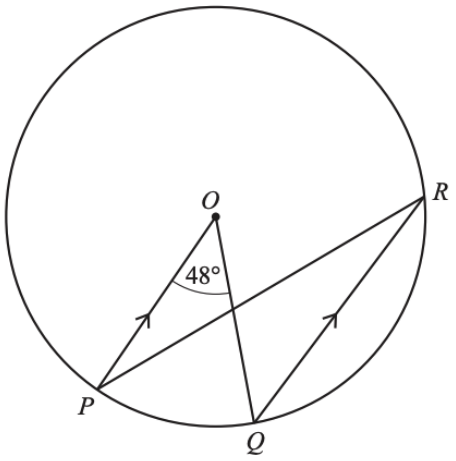
NOT TO SCALE

A, B, C and D are points on the circumference of the circle, centre O.
DOB is a straight line and angle $DAC = 58°$.

Find angle CDB.

Angle CDB = ... [3]

(c)



NOT TO SCALE

P, Q and R are points on the circumference of the circle, centre O.
PO is parallel to QR and angle $POQ = 48°$.

(i) Find angle OPR.

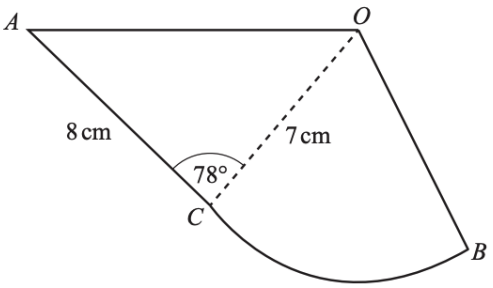
Angle OPR = ... [2]

(ii) The radius of the circle is 5.4 cm.

Calculate the length of the **major** arc PQ.

..... cm [3]

5



NOT TO SCALE

The diagram shows a design made from a triangle AOC joined to a sector OCB.
$AC = 8$ cm, $OB = OC = 7$ cm and angle $ACO = 78°$.

(a) Use the cosine rule to show that $OA = 9.47$ cm, correct to 2 decimal places.

[4]

(b) Calculate angle OAC.

Angle OAC = ... [3]

(c) The perimeter of the design is 29.5 cm.

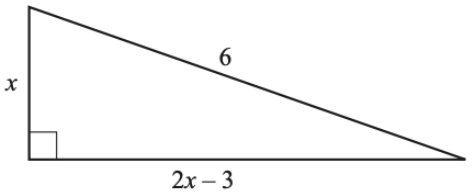
Show that angle $COB = 41.2°$, correct to 1 decimal place.

[5]

(d) Calculate the total area of the design.

..... cm^2 [4]

7 In this question, all measurements are in metres.



NOT TO SCALE

The diagram shows a right-angled triangle.

(a) Show that $5x^2 - 12x - 27 = 0$.

[3]

(b) Solve $5x^2 - 12x - 27 = 0$.
Show all your working and give your answers correct to 2 decimal places.

$x =$ ..... or $x =$ ..... [4]

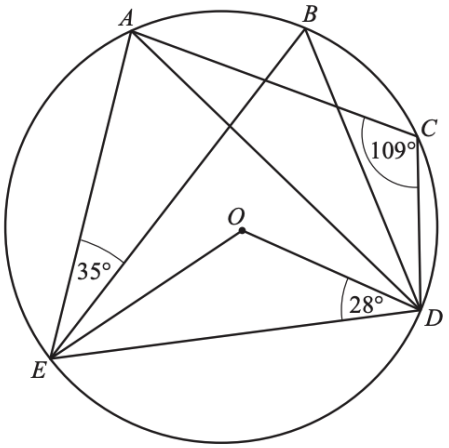
(c) Calculate the perimeter of the triangle.

..... m [2]

(d) Calculate the smallest angle of the triangle.

..... [2]

9 (a)



NOT TO SCALE

A, B, C, D and E lie on the circle, centre O.
Angle $AEB = 35°$, angle $ODE = 28°$ and angle $ACD = 109°$.

(i) Work out the following angles, giving reasons for your answers.

(a) Angle EBD = ... because .....

.....

..... [3]

(b) Angle EAD = ... because .....

..... [2]

(ii) Work out angle BEO.

Angle BEO = ... [3]

(b) In a regular polygon, the interior angle is 11 times the exterior angle.

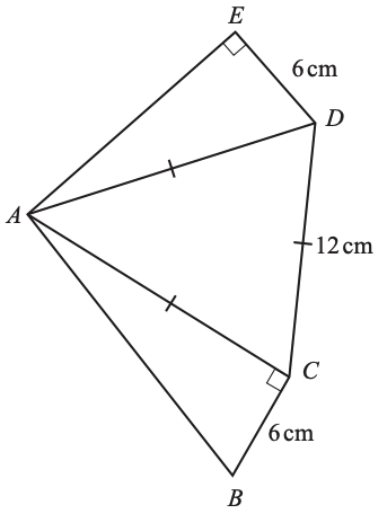
(i) Work out the number of sides of this polygon.

..... [3]

(ii) Find the sum of the interior angles of this polygon.

..... [2]

6 (a)



NOT TO SCALE

In the pentagon $ABCDE$, angle ACB = angle $AED = 90°$.
Triangle ACD is equilateral with side length 12 cm.
$DE = BC = 6$ cm.

(i) Calculate angle BAE.

Angle BAE = ... [4]

(ii) Calculate AB.

AB = ... cm [2]

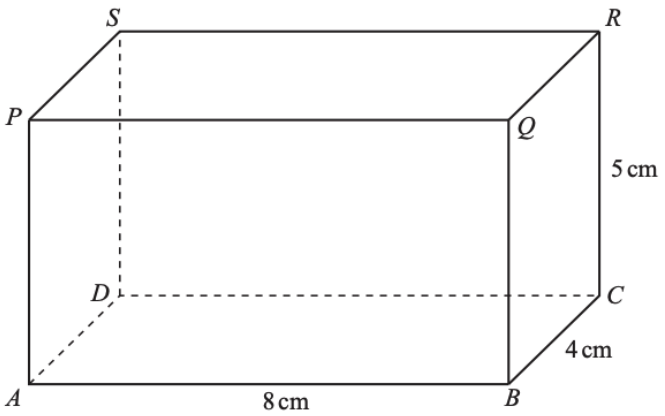
(iii) Calculate AE.

AE = ... cm [3]

(iv) Calculate the area of the pentagon.

..... cm^2 [4]

(b)



NOT TO SCALE

The diagram shows a cuboid.
$AB = 8$ cm, $BC = 4$ cm and $CR = 5$ cm.

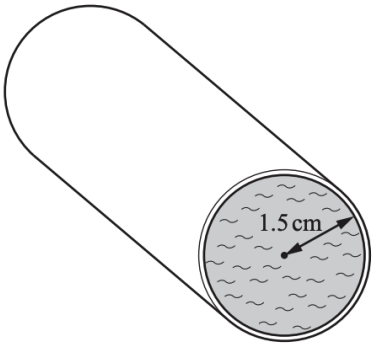
(i) Write down the number of planes of symmetry of this cuboid.

..... [1]

(ii) Calculate the angle between the diagonal AR and the plane $BCRQ$.

..... [4]

7 (a)



NOT TO
SCALE

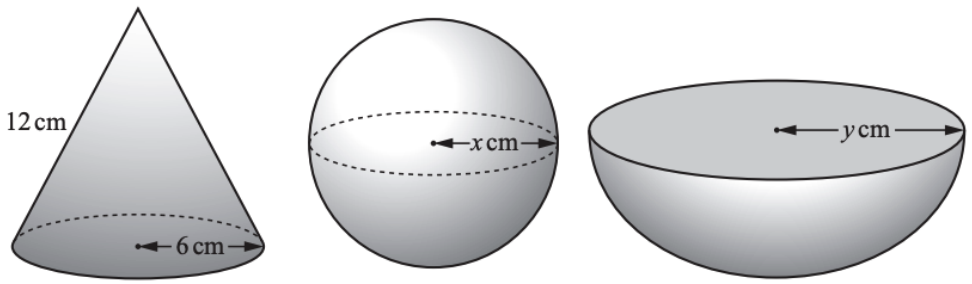
Water flows through a cylindrical pipe at a speed of 8 cm/s.
The radius of the circular cross-section is 1.5 cm and the pipe is always completely full of water.

Calculate the amount of water that flows through the pipe in 1 hour.
Give your answer in litres.

..... litres [4]

(b)

NOT TO SCALE



The diagram shows three solids.
The base radius of the cone is 6 cm and the slant height is 12 cm.
The radius of the sphere is x cm and the radius of the hemisphere is y cm.
The **total** surface area of each solid is the same.

(i) Show that the total surface area of the cone is $108\pi\,\text{cm}^2$.

[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

[2]

(ii) Find the value of x and the value of y.

[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

x = ...

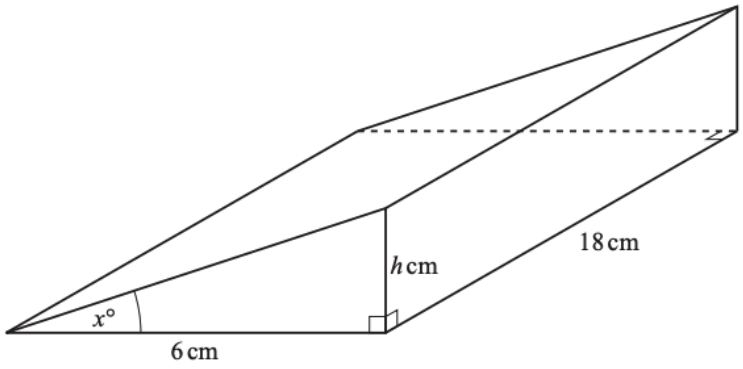
y = ... [4]

(b) Marianne sells two sizes of photo.
These photos are mathematically similar rectangles.
The smaller photo has length 15 cm and width 12 cm.
The larger photo has area 352.8 cm^2.

Calculate the length of the larger photo.

..... cm [3]

5



NOT TO SCALE

The diagram shows a prism with length 18 cm and volume 253.8 cm^3.
The cross-section of the prism is a right-angled triangle with base 6 cm and height h cm.

(a) (i) Show that the value of h is 4.7 .

[3]

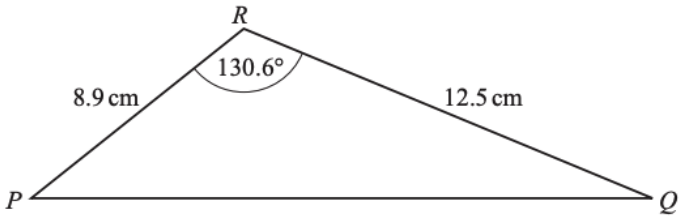
(ii) Calculate the value of x.

$x =$ ..... [2]

(b) Calculate the total surface area of the prism.

..... cm^2 [6]

7 **(a)**

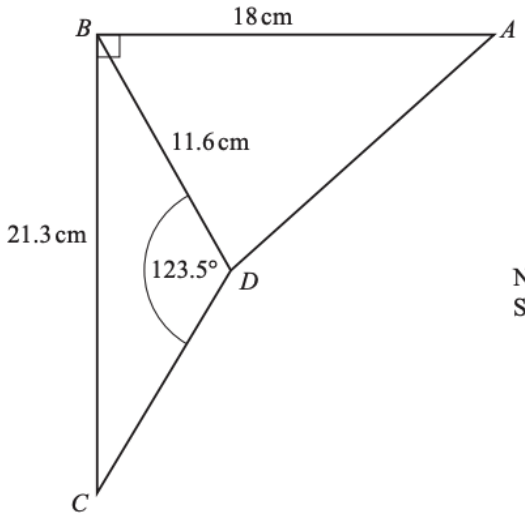


NOT TO SCALE

Calculate the area of triangle *PQR*.

..... cm^2 [2]

(b)



NOT TO SCALE

In the diagram, $AB = 18$ cm, $BC = 21.3$ cm and $BD = 11.6$ cm.
Angle $BDC = 123.5°$ and angle ABC is a right angle.

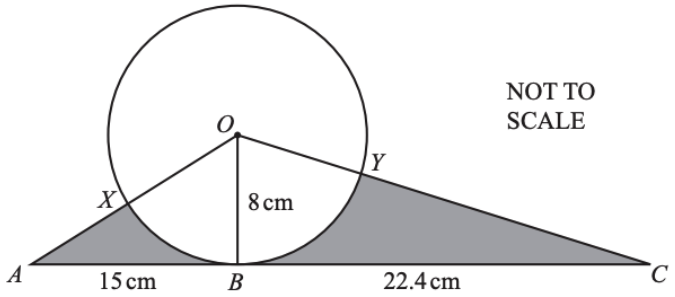
(i) Calculate angle *BCD*.

Angle *BCD* = ... [3]

(ii) Calculate AD.

AD = ... cm [5]

10



The diagram shows a circle, centre O.
The straight line ABC is a tangent to the circle at B.
$OB = 8$ cm, $AB = 15$ cm and $BC = 22.4$ cm.
AO crosses the circle at X and OC crosses the circle at Y.

(a) Calculate angle XOY.

Angle XOY = ... [5]

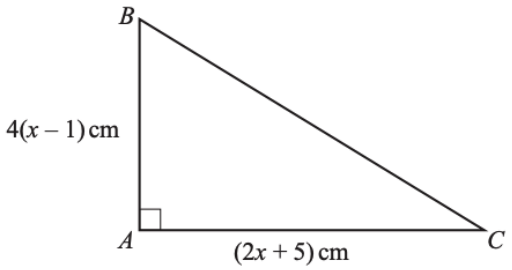
(b) Calculate the length of the arc XBY.

..... cm [2]

(c) Calculate the total area of the two shaded regions.

..... cm^2 [4]

4 The diagram shows a right-angled triangle ABC.



NOT TO SCALE

The area of this triangle is $30\,cm^2$.

(a) Show that $2x^2 + 3x - 20 = 0$.

[3]

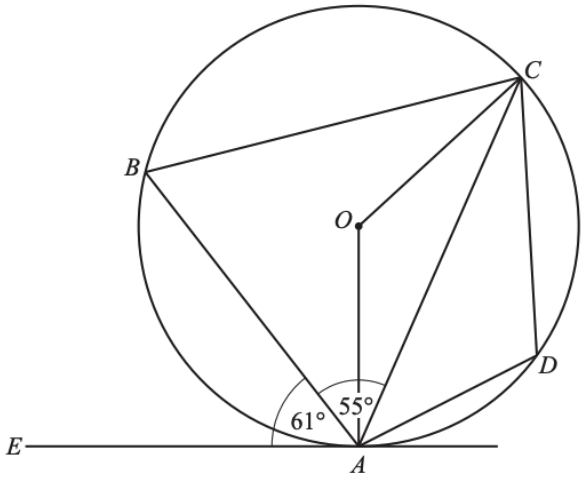
(b) Use factorisation to solve the equation $2x^2 + 3x - 20 = 0$.

$x =$ ..... or $x =$ ..... [3]

(c) Calculate BC.

$BC =$..... cm [3]

7



NOT TO SCALE

In the diagram, A, B, C and D lie on the circle, centre O.
EA is a tangent to the circle at A.
Angle $EAB = 61°$ and angle $BAC = 55°$.

(a) Find angle BAO.

Angle BAO = ... [1]

(b) Find angle AOC.

Angle AOC = ... [2]

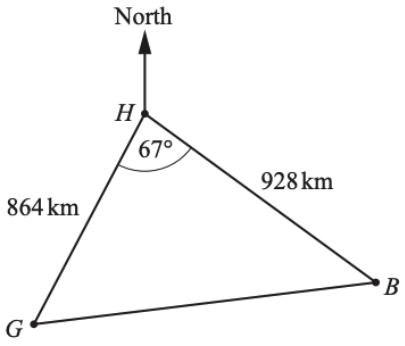
(c) Find angle ABC.

Angle ABC = ... [1]

(d) Find angle CDA.

Angle CDA = ... [1]

8 The diagram shows the positions of three cities, Geneva (G), Budapest (B) and Hamburg (H).



NOT TO SCALE

(a) A plane flies from Geneva to Hamburg.
The flight takes 2 hours 20 minutes.

Calculate the average speed in kilometres per hour.

..... km/h [2]

(b) Use the cosine rule to calculate the distance from Geneva to Budapest.

..... km [4]

(c) The bearing of Budapest from Hamburg is 133°.

(i) Find the bearing of Hamburg from Budapest.

..... [2]

(ii) Calculate the bearing of Budapest from Geneva.

..... [4]

10 **(a)** The lake behind a dam has an area of 55 hectares.
When the gates in the dam are open, water flows out at a rate of 75 000 litres per second.

(i) Show that 90 million litres of water flows out in 20 minutes.

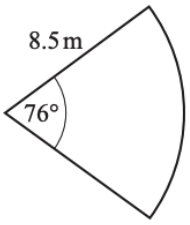
[1]

(ii) Beneath the surface, the lake has vertical sides.

Calculate the drop in the water level of the lake when the gates are open for 20 minutes.
Give your answer in centimetres.
[1 hectare = $10^4 m^2$, 1000 litres = $1 m^3$]

..... cm [3]

(iii)



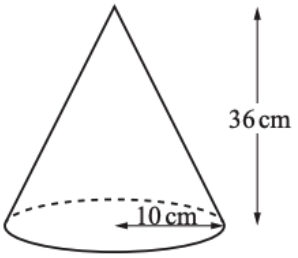
NOT TO SCALE

The cross-section of a gate is a sector of a circle with radius 8.5 m and angle 76°.

Calculate the perimeter of the sector.

..... m [3]

(b)



NOT TO SCALE

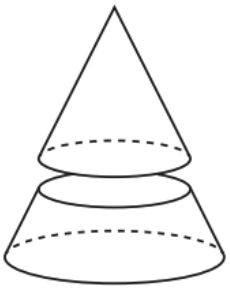
A solid metal cone has radius 10 cm and height 36 cm.

(i) Calculate the volume of this cone.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

..... cm^3 [2]

(ii) The cone is cut, parallel to its base, to give a smaller cone.



NOT TO SCALE

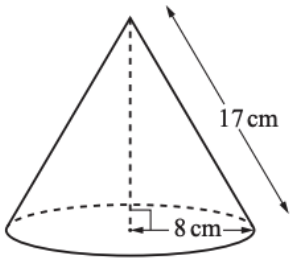
The volume of the smaller cone is half the volume of the original cone.
The smaller cone is melted down to make two different spheres.
The ratio of the radii of these two spheres is 1 : 2.

Calculate the radius of the smaller sphere.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... cm [4]

3 (a)



NOT TO SCALE

The diagram shows a solid cone.
The radius is 8 cm and the slant height is 17 cm.

(i) Calculate the curved surface area of the cone.

[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

..... cm^2 [2]

(ii) Calculate the volume of the cone.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

..... cm^3 [4]

(iii) The cone is made of wood and 1 cm^3 of the wood has a mass of 0.8 g.

Calculate the mass of the cone.

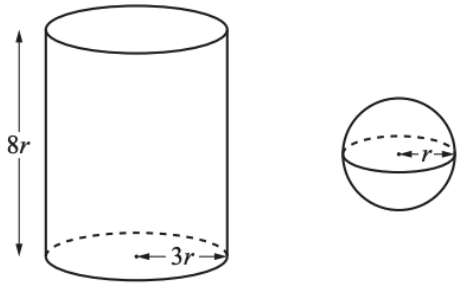
..... g [1]

(iv) The cone is placed in a box.
The total mass of the cone and the box is 1.2 kg.

Calculate the mass of the box.
Give your answer in grams.

..... g [1]

(b)



NOT TO SCALE

The diagram shows a solid cylinder and a solid sphere.
The cylinder has radius $3r$ and height $8r$.
The sphere has radius r.

(i) Find the volume of the sphere as a fraction of the volume of the cylinder.
Give your answer in its lowest terms.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... [4]

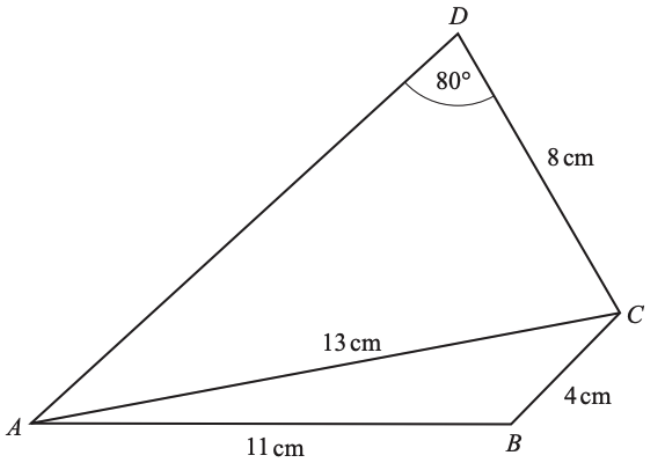
(ii) The surface area of the sphere is $81\pi\,\text{cm}^2$.

Find the **curved** surface area of the cylinder.
Give your answer in terms of π.

[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

..... cm^2 [4]

6



NOT TO SCALE

(a) Calculate angle ACB.

Angle ACB = ... [4]

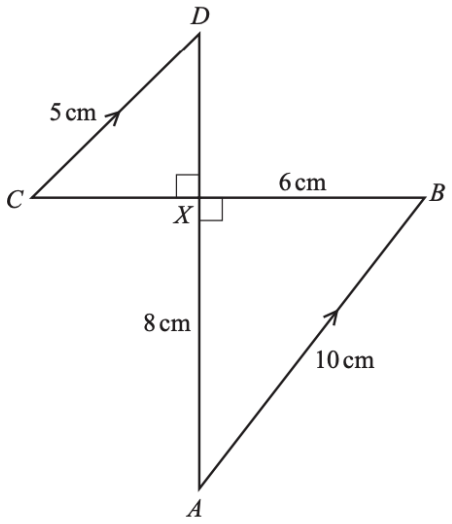
(b) Calculate angle ACD.

Angle ACD = ... [4]

(c) Calculate the area of the quadrilateral $ABCD$.

..... cm^2 [3]

8 (a)



NOT TO SCALE

In the diagram, AB and CD are parallel.
AD and BC intersect at right angles at the point X.
$AB = 10$ cm, $CD = 5$ cm, $AX = 8$ cm and $BX = 6$ cm.

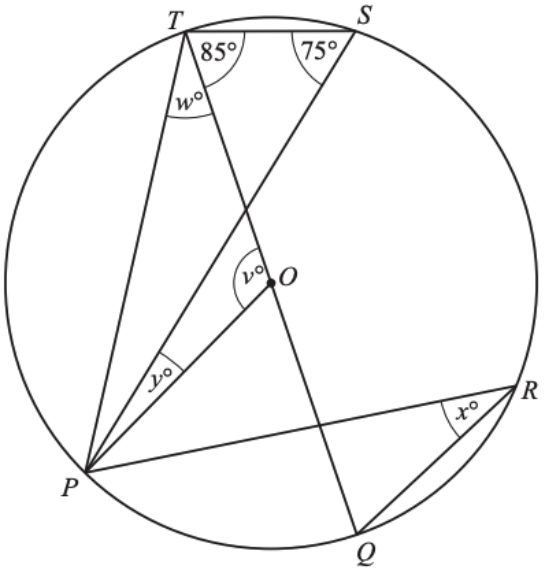
(i) Use similar triangles to calculate DX.

$DX =$ ..... cm [2]

(ii) Calculate angle XAB.

Angle $XAB =$ ..... [2]

(b)



NOT TO SCALE

P, Q, R, S and T lie on the circle, centre O.
Angle $PST = 75°$ and angle $QTS = 85°$.

Find the values of v, w, x and y.

$v =$ .....

$w =$ .....

$x =$ .....

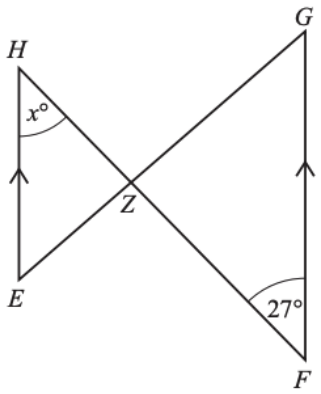
$y =$ ..... [6]

(c) Two containers are mathematically similar.
The surface area of the larger container is $226\,cm^2$ and the surface area of the smaller container is $94\,cm^2$.
The volume of the larger container is $680\,cm^3$.

Find the volume of the smaller container.

..... cm^3 [3]

6 **(a)**



NOT TO SCALE

In the diagram, EH is parallel to FG.
The straight lines EG and FH intersect at Z.
Angle $ZFG = 27°$.

(i) Find the value of x.

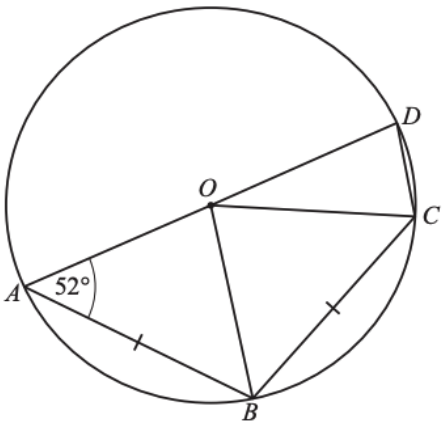
$x =$ ..... [1]

(ii) $EH = 5$ cm, $FG = 9$ cm and $ZG = 7$ cm.

Calculate EZ.

$EZ =$ ..... cm [2]

(b) The diagram shows points A, B, C and D on the circumference of a circle, centre O.
AD is a straight line, $AB = BC$ and angle $OAB = 52°$.

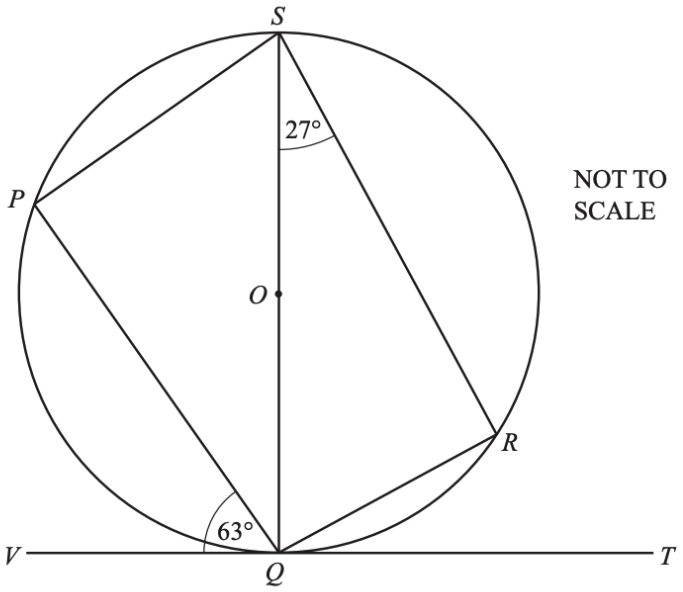


NOT TO SCALE

Find angle ADC.

Angle $ADC =$ ..... [3]

(c) The diagram shows points P, Q, R and S on the circumference of a circle, centre O.
VT is the tangent to the circle at Q.



Complete the statements.

(i) Angle QPS = angle QRS = ... ° because .....

..... [2]

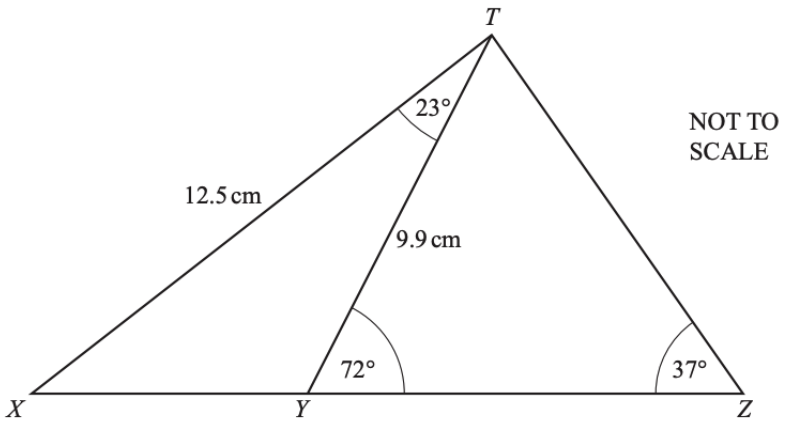
(ii) Angle SQP = ... ° because .....

..... [2]

(iii) **Part (c)(i)** and **part (c)(ii)** show that

the cyclic quadrilateral $PQRS$ is a ..... [1]

8 **(a)** In triangle TXZ, $TX = 12.5$ cm and angle $TZX = 37°$.
Y is a point on the line XZ such that $TY = 9.9$ cm, angle $XTY = 23°$ and angle $TYZ = 72°$.



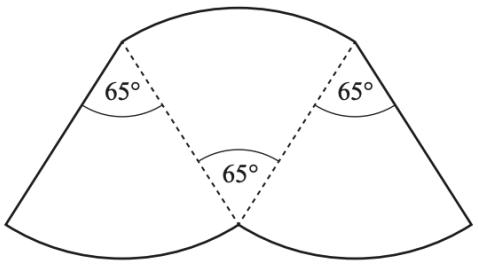
(i) Calculate XY.

$XY =$ ..... cm [4]

(ii) Calculate TZ.

$TZ =$ ..... cm [3]

(b) The diagram shows a shape made up of three identical sectors of a circle, each with sector angle 65°.
The perimeter of the shape is 20.5 cm.

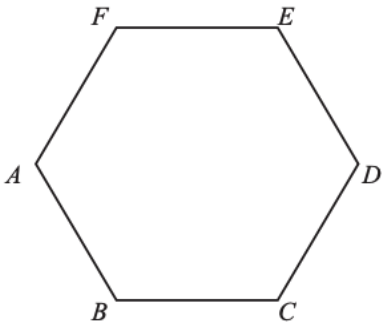


NOT TO
SCALE

Calculate the radius of the circle.

..... cm [4]

10 **(a)** The diagram shows a regular hexagon $ABCDEF$ of side 10 cm.



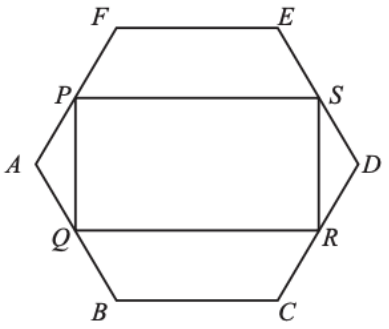
NOT TO SCALE

(i) Show that angle $BAF = 120°$.

[2]

(ii) The vertices of a rectangle $PQRS$ touch the sides FA, AB, CD and DE.

PS is parallel to FE and $AP = x$ cm.



NOT TO SCALE

Use trigonometry to find the length of PQ in terms of x.

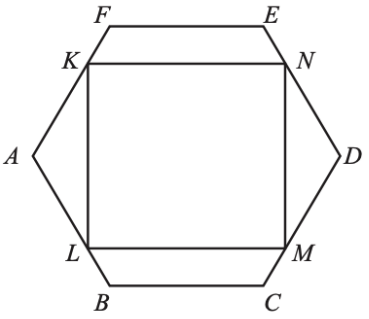
$PQ =$ ..... cm [3]

(iii) $PF = (10 - x)$ cm.

Show that $PS = (20 - x)$ cm.

[3]

(b)



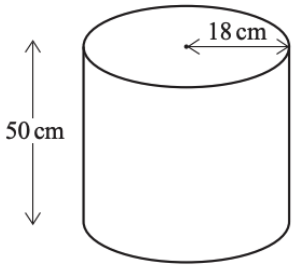
NOT TO SCALE

The diagram shows the vertices of a square *KLMN* touching the sides of the same hexagon *ABCDEF*, with *KN* parallel to *FE*.

Use your results from **part (a)(ii)** and **part (a)(iii)** to find the length of a side of the square.

..... cm [4]

5 **(a)** The diagram shows a cylindrical container used to serve coffee in a hotel.



NOT TO SCALE

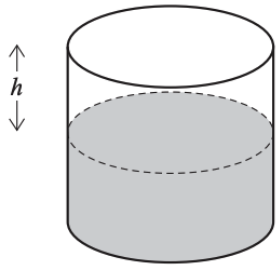
The container has a height of 50 cm and a radius of 18 cm.

(i) Calculate the volume of the cylinder and show that it rounds to 50 900 cm^3, correct to 3 significant figures.

[2]

(ii) 30 litres of coffee are poured into the container.

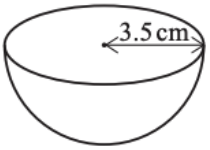
Work out the height, h, of the empty space in the container.



NOT TO SCALE

h = ... cm [3]

(iii) Cups in the shape of a hemisphere are filled with coffee from the container.
The radius of a cup is 3.5 cm.



NOT TO SCALE

Work out the maximum number of these cups that can be completely filled from the 30 litres of coffee in the container.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... [4]

(b) The hotel also uses glasses in the shape of a cone.

NOT TO SCALE

The capacity of each glass is 95 cm^3.

(i) Calculate the radius, r, and show that it rounds to 3.3 cm, correct to 1 decimal place.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

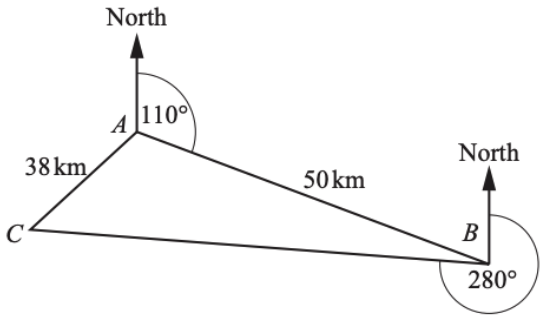
[3]

(ii) Calculate the curved surface area of the cone.

[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi r l$.]

..... cm^2 [4]

8 (a)



NOT TO SCALE

A, B and C are three towns.
The bearing of B from A is 110°.
The bearing of C from B is 280°.
$AC = 38$ km and $AB = 50$ km.

(i) Find the bearing of A from B.

..... [2]

(ii) Calculate angle BAC.

Angle BAC = ... [5]

(iii) A road is built from A to join the straight road BC.

Calculate the shortest possible length of this new road.

..... km [3]

(b) Town A has a rectangular park.
The length of the park is x m.
The width of the park is 25 m shorter than the length.
The area of the park is $2200\,\text{m}^2$.

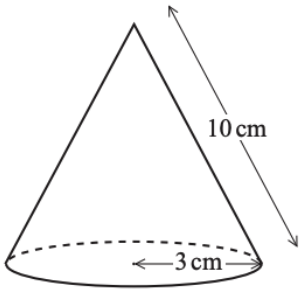
(i) Show that $x^2 - 25x - 2200 = 0$.

[1]

(ii) Solve $x^2 - 25x - 2200 = 0$.
Show all your working and give your answers correct to 2 decimal places.

$x =$ ..... or $x =$ ..... [4]

5



NOT TO SCALE

The diagram shows a hollow cone with radius 3 cm and slant height 10 cm.

(a) (i) Calculate the curved surface area of the cone.

[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

..... cm^2 [2]

(ii) Calculate the perpendicular height of the cone.

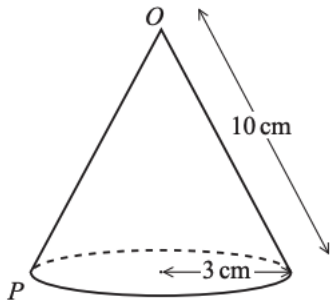
..... cm [3]

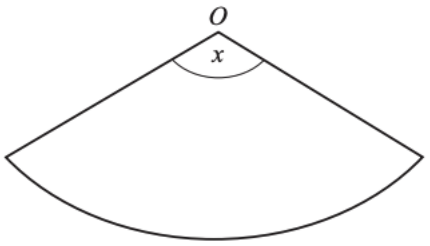
(iii) Calculate the volume of the cone.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

..... cm^3 [2]

(b)





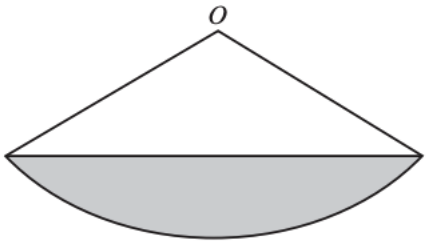
NOT TO SCALE

The cone is cut along the line OP and is opened out into a sector as shown in the diagram.

Calculate the sector angle x.

$x =$ ..... [4]

(c)



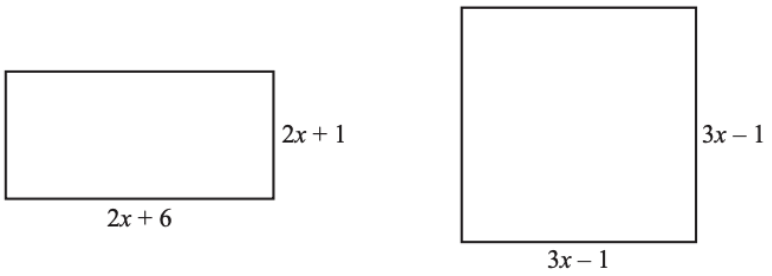
NOT TO SCALE

The diagram shows the same sector as in **part (b)**.

Calculate the area of the shaded segment.

..... cm^2 [4]

7 **(a)** In this part, all lengths are in centimetres.



NOT TO SCALE

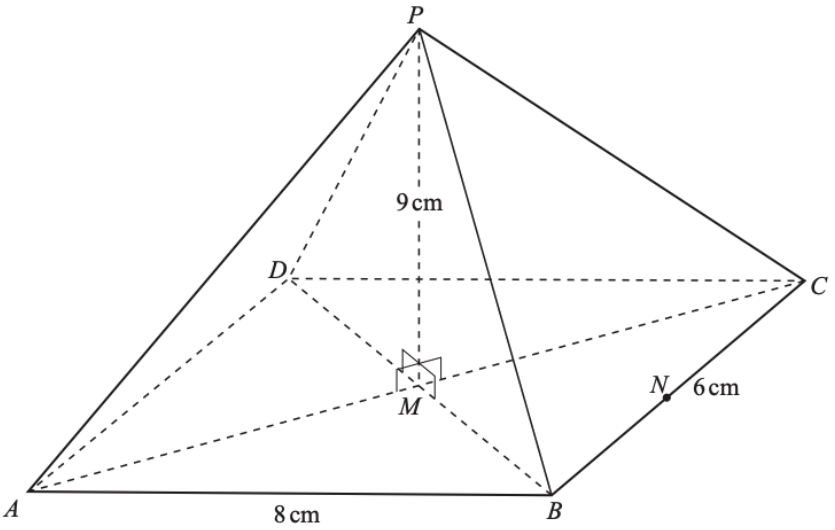
(i) Find the value of x when the perimeter of the rectangle is equal to the perimeter of the square.

$x =$ ..... [3]

(ii) Find the value of x when the area of the rectangle is equal to the area of the square.
Show all your working.

$x =$ ..... [7]

8



NOT TO SCALE

The diagram shows a pyramid on a rectangular base $ABCD$.
AC and BD intersect at M and P is vertically above M.
$AB = 8$ cm, $BC = 6$ cm and $PM = 9$ cm.

(a) N is the midpoint of BC.

Calculate angle PNM.

Angle PNM = ... [2]

(b) Show that $BM = 5$ cm.

[1]

(c) Calculate the angle between the edge PB and the base $ABCD$.

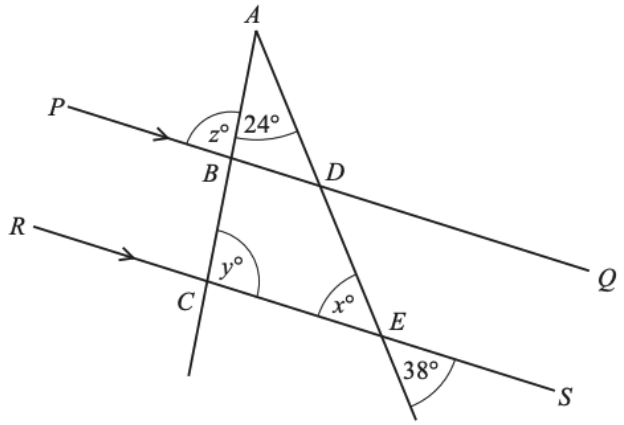
..... [2]

(d) A point X is on PC so that $PX = 7.5$ cm.

Calculate BX.

$BX =$ ..... cm [6]

2 **(a)**



NOT TO SCALE

PQ is parallel to RS.
ABC and ADE are straight lines.

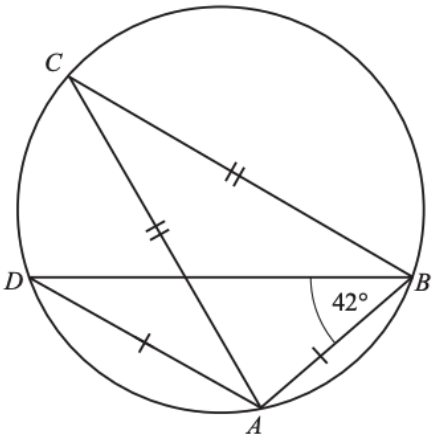
Find the values of x, y and z.

x = ...

y = ...

z = ... [3]

(b)



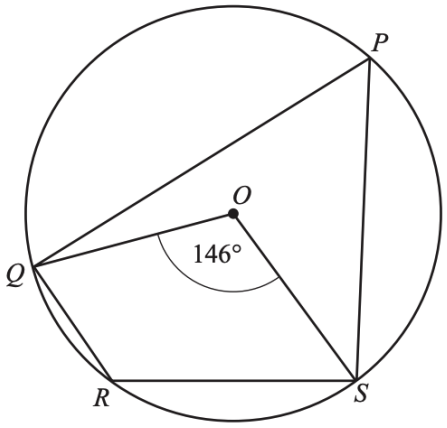
NOT TO SCALE

The points A, B, C and D lie on the circumference of the circle.
$AB = AD$, $AC = BC$ and angle $ABD = 42°$.

Find angle CAB.

Angle CAB = ... [3]

(c)



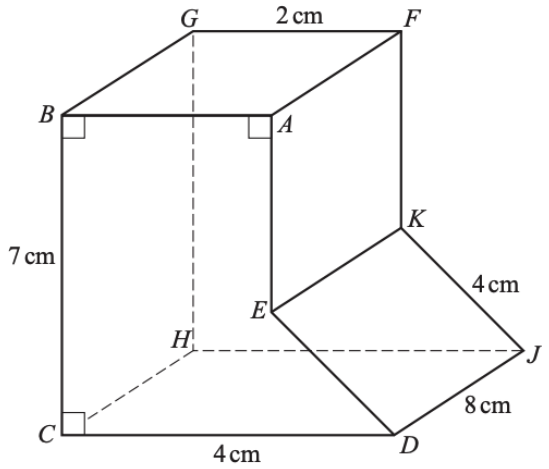
NOT TO SCALE

The points P, Q, R and S lie on the circumference of the circle, centre O.
Angle $QOS = 146°$.

Find angle QRS.

Angle QRS = ... [2]

4 **(a)** The diagram shows a solid metal prism with cross section *ABCDE*.



NOT TO SCALE

(i) Calculate the area of the cross section *ABCDE*.

..... cm^2 [6]

(ii) The prism is of length 8 cm.

Calculate the volume of the prism.

..... cm^3 [1]

(b) A cylinder of length 13 cm has volume 280 cm^3.

(i) Calculate the radius of the cylinder.

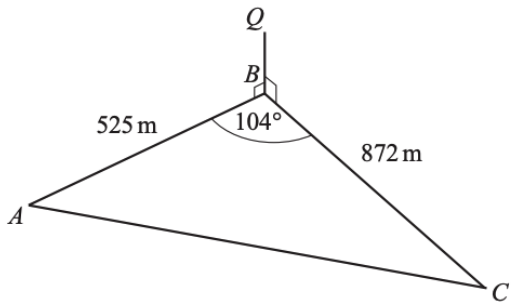
..... cm [3]

(ii) The cylinder is placed in a box that is a cube of side 14 cm.

Calculate the percentage of the volume of the box that is occupied by the cylinder.

.....% [3]

9



NOT TO SCALE

ABC is a triangular field on horizontal ground.
There is a vertical pole BQ at B.
$AB = 525$ m, $BC = 872$ m and angle $ABC = 104°$.

(a) Use the cosine rule to calculate the distance AC.

$AC =$ ..... m [4]

(b) The angle of elevation of Q from C is 1.0°.

Showing all your working, calculate the angle of elevation of Q from A.

..... [4]

(c) **(i)** Calculate the area of the field.

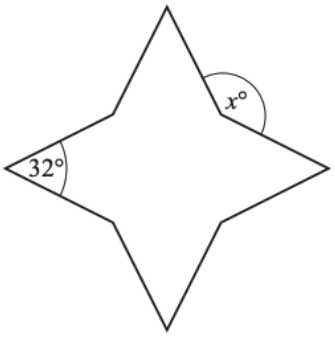
..... m^2 [2]

(ii) The field is drawn on a map with the scale 1 : 20 000.

Calculate the area of the field on the map in cm^2.

.....cm^2 [2]

2 **(a)**



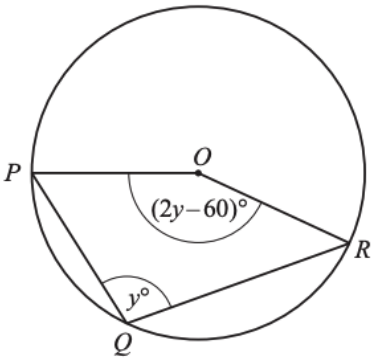
NOT TO SCALE

The diagram shows an octagon.
All of the sides are the same length.
Four of the interior angles are each 32°.
The other four interior angles are equal.

Find the value of x.

$x =$ ..... [4]

(b)



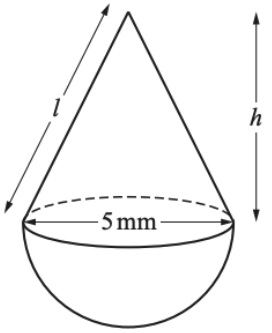
NOT TO SCALE

P, Q and R lie on a circle, centre O.
Angle $PQR = y°$ and angle $POR = (2y - 60)°$.

Find the value of y.

$y =$ ..... [3]

8



NOT TO SCALE

The diagram shows a solid made from a hemisphere and a cone.
The base diameter of the cone and the diameter of the hemisphere are each 5 mm.

(a) The total surface area of the solid is $\frac{115\pi}{4}$ mm^2.

Show that the slant height, l, is 6.5 mm.

[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]
[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

[4]

(b) Calculate the height, h, of the cone.

h = ... mm [3]

(c) Calculate the volume of the solid.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

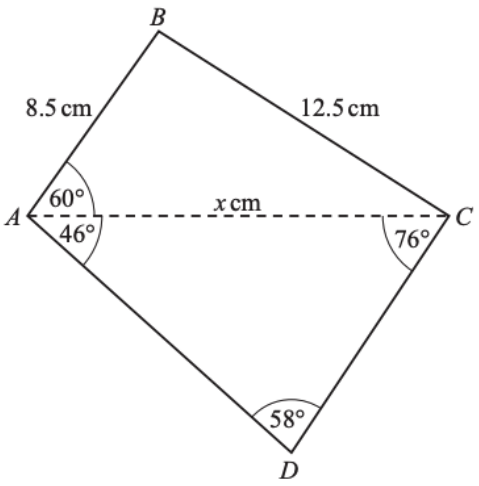
.....mm^3 [4]

(d) The solid is made from gold.
1 **cubic centimetre** of gold has a mass of 19.3 grams.
The value of 1 gram of gold is $38.62 .

Calculate the value of the gold used to make the solid.

$..... [3]

10



NOT TO SCALE

The diagram shows a quadrilateral $ABCD$.

(a) The length of AC is x cm.

Use the cosine rule in triangle ABC to show that $2x^2 - 17x - 168 = 0$.

[4]

(b) Solve the equation $2x^2 - 17x - 168 = 0$.
Show all your working and give your answers correct to 2 decimal places.

$x =$ ..... or $x =$ ..... [4]

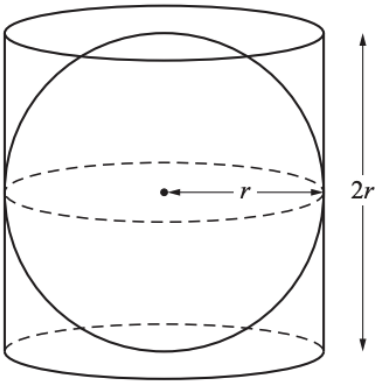
(c) Use the sine rule to calculate the length of CD.

CD = ... cm [3]

(d) Calculate the area of the quadrilateral $ABCD$.

..... cm^2 [3]

2 (a)



NOT TO SCALE

A sphere of radius r is inside a closed cylinder of radius r and height $2r$.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

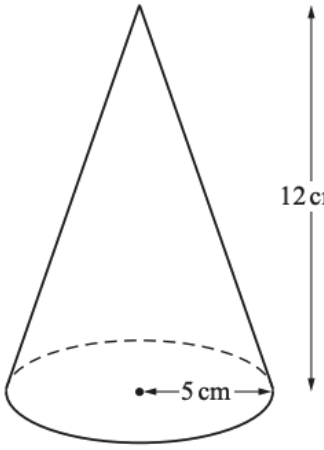
(i) When $r = 8$ cm, calculate the volume inside the cylinder which is **not** occupied by the sphere.

..... cm^3 [3]

(ii) Find r when the volume inside the cylinder **not** occupied by the sphere is $36\,cm^3$.

$r =$ ..... cm [3]

(b)



NOT TO SCALE

The diagram shows a solid cone with radius 5 cm and perpendicular height 12 cm.

(i) The **total** surface area is painted at a cost of \$0.015 per cm^2.

Calculate the cost of painting the cone.

[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi rl$.]

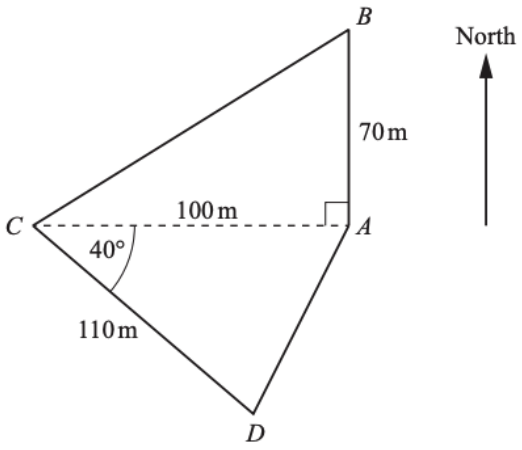
\$ ..... [4]

(ii) The cone is made of metal and is melted down and made into smaller solid cones with radius 1.25 cm and perpendicular height 3 cm.

Calculate the number of smaller cones that can be made.

..... [3]

3



The diagram shows a field *ABCD*.

(a) Calculate the area of the field *ABCD*.

.....m^2 [3]

(b) Calculate the perimeter of the field *ABCD*.

..... m [5]

(c) Calculate the shortest distance from A to CD.

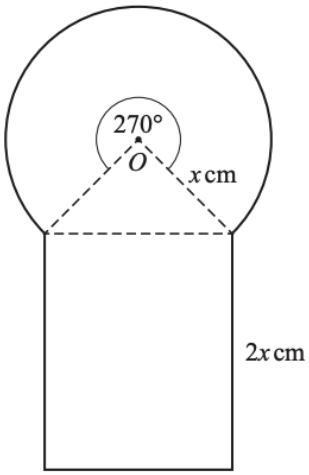
..... m [2]

(d) B is due north of A.

Find the bearing of C from B.

..... [3]

10



NOT TO SCALE

The diagram shows a sector of a circle, a triangle and a rectangle.
The sector has centre O, radius x cm and angle 270°.
The rectangle has length $2x$ cm.

The total area of the shape is kx^2 cm^2.

(a) Find the value of k.

$k =$ ..... [5]

(b) Find the value of x when the total area is 110 cm^2.

$x =$ ..... [2]

1 **(a)** The angles of a triangle are in the ratio 2 : 3 : 5.

(i) Show that the triangle is right-angled.

[1]

(ii) The length of the hypotenuse of the triangle is 12 cm.

Use trigonometry to calculate the length of the shortest side of this triangle.

..... cm [3]

(b) The sides of a different right-angled triangle are in the ratio 3 : 4 : 5.

(i) The length of the shortest side is 7.8 cm.

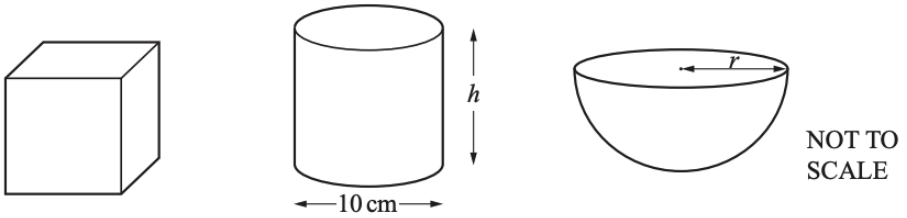
Calculate the length of the longest side.

..... cm [2]

(ii) Calculate the smallest angle in this triangle.

..... [3]

6 (a)



The diagrams show a cube, a cylinder and a hemisphere.
The volume of each of these solids is 2000 cm^3.

(i) Work out the height, h, of the cylinder.

$h =$ ..... cm [2]

(ii) Work out the radius, r, of the hemisphere.

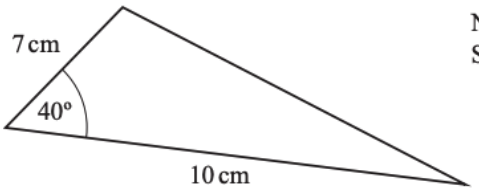
[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

$r =$ ..... cm [3]

(iii) Work out the surface area of the cube.

..... cm^2 [3]

(b)



NOT TO SCALE

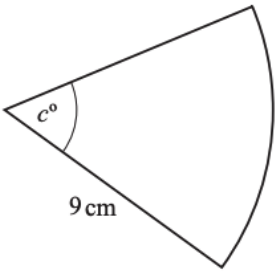
(i) Calculate the area of the triangle.

.....cm^2 [2]

(ii) Calculate the perimeter of the triangle and show that it is 23.5 cm, correct to 1 decimal place. Show all your working.

[5]

(c)



NOT TO SCALE

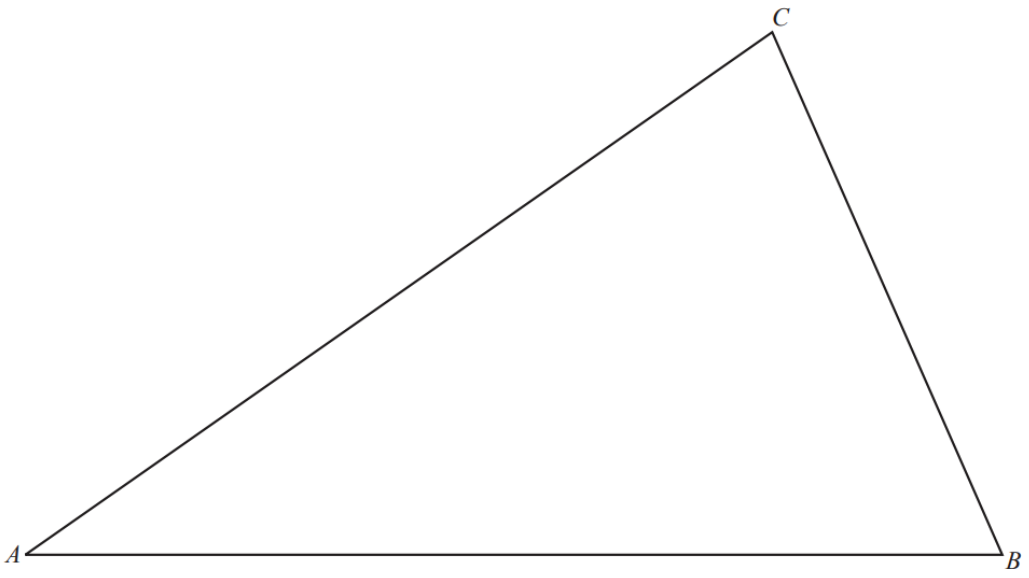
The perimeter of this sector of a circle is 28.2 cm.

Calculate the value of c.

c = ... [3]

2 **In this question use a ruler and compasses only.**
Show all your construction arcs.

The diagram shows a triangular field ABC.
The scale is 1 centimetre represents 50 metres.



Scale : 1 cm to 50 m

(a) Construct the locus of points that are equidistant from A and B. [2]

(b) Construct the locus of points that are equidistant from the lines AB and AC. [2]

(c) The two loci intersect at the point E.

Construct the locus of points that are 250 m from E. [2]

(d) Shade any region inside the field ABC that is

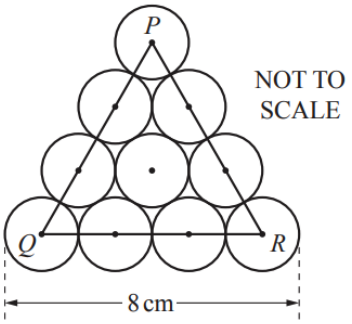
- more than 250 m from E

and

- closer to AC than to AB. [2]

10 **(a)** The ten circles in the diagram each have radius 1 cm.
The centre of each circle is marked with a dot.

Calculate the height of triangle PQR.

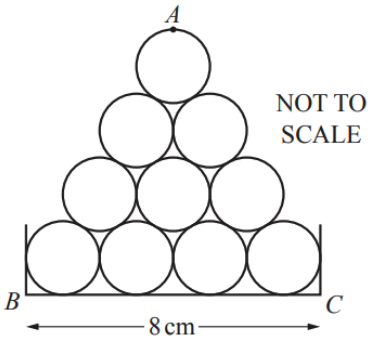


..... cm [3]

(b) Mr Patel uses whiteboard pens that are cylinders of radius 1 cm.

(i) The diagram shows 10 pens stacked in a tray.
The tray is 8 cm wide.
The point A is the highest point in the stack.

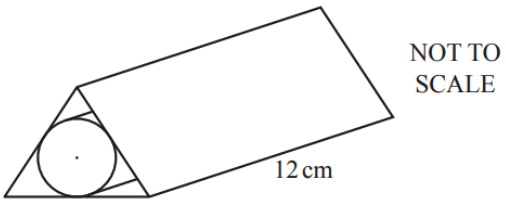
Find the height of A above the base, BC, of the tray.



..... cm [1]

(ii) The diagram shows a box that holds one pen.
The box is a prism of length 12 cm.
The cross section of the prism is an equilateral triangle.
The pen touches each of the three rectangular faces of the box.

Calculate the volume of this box.

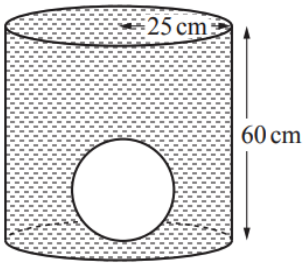


..... cm^3 [5]

4 **(a)** Calculate the volume of a metal sphere of radius 15 cm and show that it rounds to 14 140 cm^3, correct to 4 significant figures.
[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

[2]

(b) **(i)** The sphere is placed inside an empty cylindrical tank of radius 25 cm and height 60 cm.
The tank is filled with water.

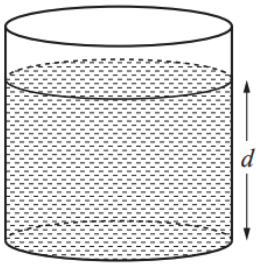


NOT TO SCALE

Calculate the volume of water required to fill the tank.

..... cm^3 [3]

(ii) The sphere is removed from the tank.



NOT TO SCALE

Calculate the depth, d, of water in the tank.

d = ... cm [2]

(c) The sphere is melted down and the metal is made into a solid cone of height 54 cm.

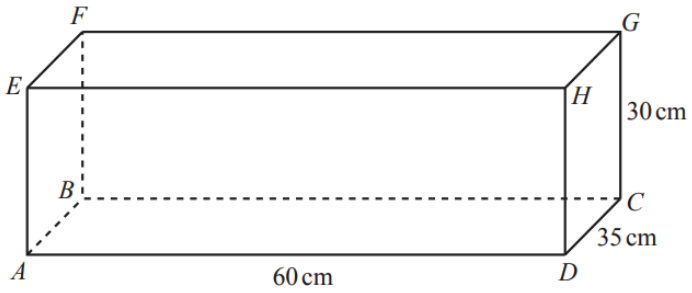
(i) Calculate the radius of the cone.
[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

..... cm [3]

(ii) Calculate the **total** surface area of the cone.
[The curved surface area, A, of a cone with radius r and slant height l is $A = \pi r l$.]

..... cm^2 [4]

6 The diagram shows a cuboid.



NOT TO SCALE

$AD = 60$ cm, $CD = 35$ cm and $CG = 30$ cm.

(a) Write down the number of planes of symmetry of this cuboid.

..... [1]

(b) **(i)** Work out the surface area of the cuboid.

..... cm^2 [3]

(ii) Write your answer to **part (b)(i)** in square metres.

..... m^2 [1]

(c) Calculate

(i) the length AG,

$AG =$ ..... cm [4]

(ii) the angle between AG and the base $ABCD$.

..... [3]

(d) **(i)** Show that the volume of the cuboid is $63\,000\,\text{cm}^3$.

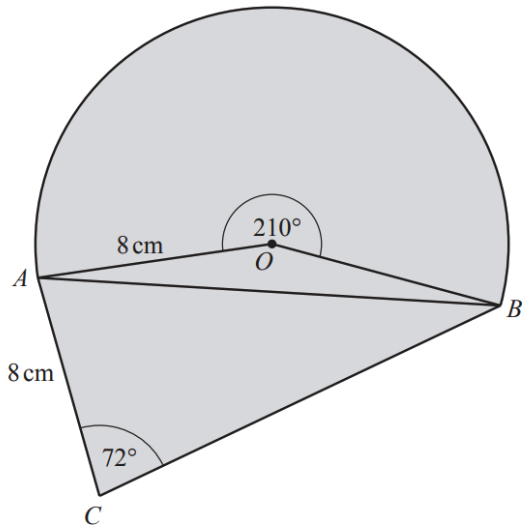
[1]

(ii) A cylinder of height 40 cm has the same volume as the cuboid.

Calculate the radius of the cylinder.

..... cm [3]

7



NOT TO SCALE

The diagram shows a design for a logo made from a sector and two triangles.
The sector, centre O, has radius 8 cm and sector angle 210°.
$AC = 8$ cm and angle $ACB = 72°$.

(a) Show that angle $OAB = 15°$.

[2]

(b) Calculate the length of the straight line AB.

$AB =$ ..... cm [4]

(c) Calculate angle ABC.

Angle ABC = ... [3]

(d) Calculate the total area of the logo design.

.....cm^2 [6]

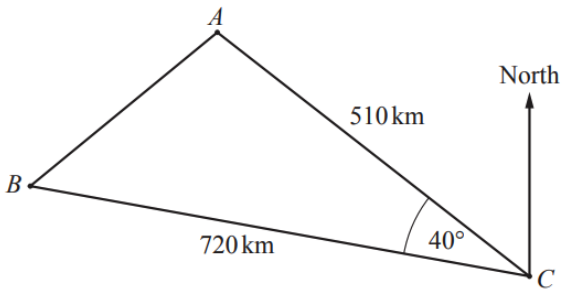
(e) The logo design is an enlargement with scale factor 4 of the actual logo.

Calculate the area of the actual logo.

.....cm^2 [2]

5

NOT TO SCALE



A plane flies from A to C and then from C to B.
$AC = 510$ km and $CB = 720$ km.
The bearing of C from A is 135° and angle $ACB = 40°$.

(a) Find the bearing of

(i) B from C,

..... [2]

(ii) C from B.

..... [2]

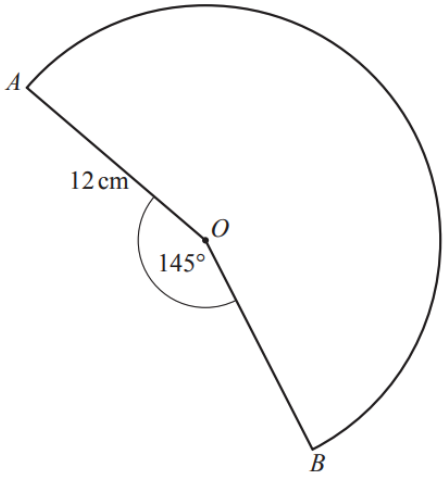
(b) Calculate AB and show that it rounds to 464.7 km, correct to 1 decimal place.

[4]

(c) Calculate angle ABC.

Angle ABC = ... [3]

9



NOT TO SCALE

The diagram shows a sector, centre O, and radius 12 cm.

(a) Calculate the area of the sector.

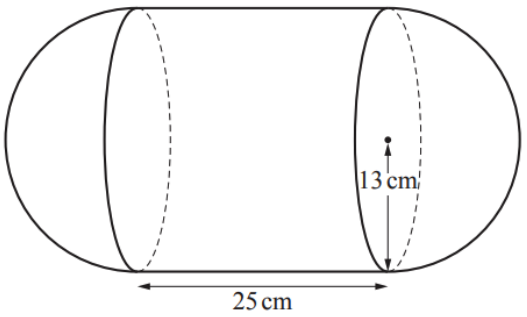
..... cm^2 [3]

(b) The sector is made into a cone by joining OA to OB.

Calculate the volume of the cone.
[The volume, V, of a cone with base radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

..... cm^3 [6]

3 **(a)**



NOT TO SCALE

The diagram shows a solid made up of a cylinder and two hemispheres.
The radius of the cylinder and the hemispheres is 13 cm.
The length of the cylinder is 25 cm.

(i) One cubic centimetre of the solid has a mass of 2.3 g.

Calculate the mass of the solid.
Give your answer in kilograms.

[The volume, V, of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

..... kg [4]

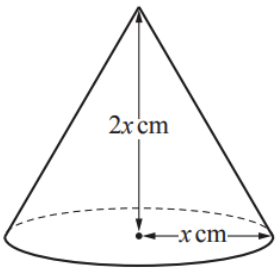
(ii) The surface of the solid is painted at a cost of $4.70 per square metre.

Calculate the cost of painting the solid.

[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

$..... [4]

(b)



NOT TO SCALE

The cone in the diagram has radius x cm and height $2x$ cm.
The volume of the cone is $500\,\text{cm}^3$.

Find the value of x.

[The volume, V, of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

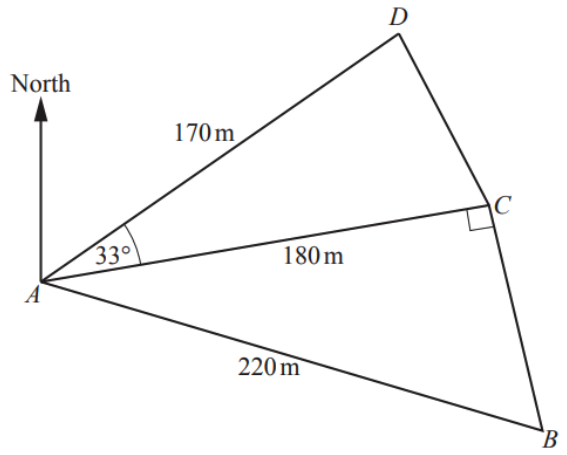
$x =$ ..... [3]

(c) Two mathematically similar solids have volumes of $180\,\text{cm}^3$ and $360\,\text{cm}^3$.
The surface area of the smaller solid is $180\,\text{cm}^2$.

Calculate the surface area of the larger solid.

..... cm^2 [3]

6



NOT TO SCALE

The diagram shows five straight footpaths in a park.
$AB = 220$ m, $AC = 180$ m and $AD = 170$ m.
Angle $ACB = 90°$ and angle $DAC = 33°$.

(a) Calculate BC.

$BC =$ ..... m [3]

(b) Calculate CD.

$CD =$ ..... m [4]

(c) Calculate the shortest distance from D to AC.

..... m [2]

(d) The bearing of D from A is 047°.

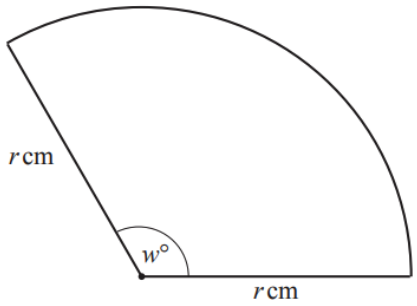
Calculate the bearing of B from A.

..... [3]

(e) Calculate the area of the quadrilateral $ABCD$.

..... m^2 [3]

10 (a)



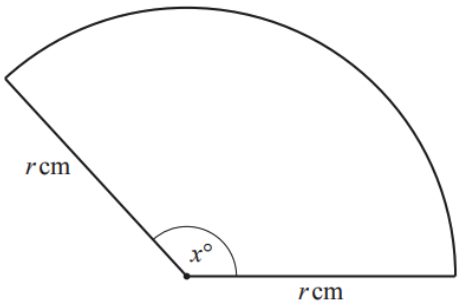
NOT TO SCALE

The area of this sector is r^2 square centimetres.

Find the value of w.

$w =$ ..... [3]

(b)



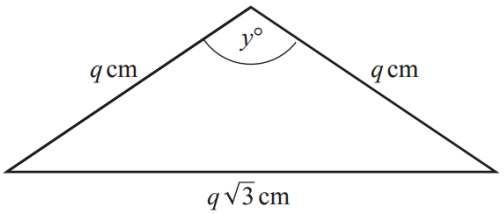
NOT TO SCALE

The perimeter of this sector is $2r + \frac{7\pi r}{10}$ centimetres.

Find the value of x.

$x =$ ..... [3]

(c)



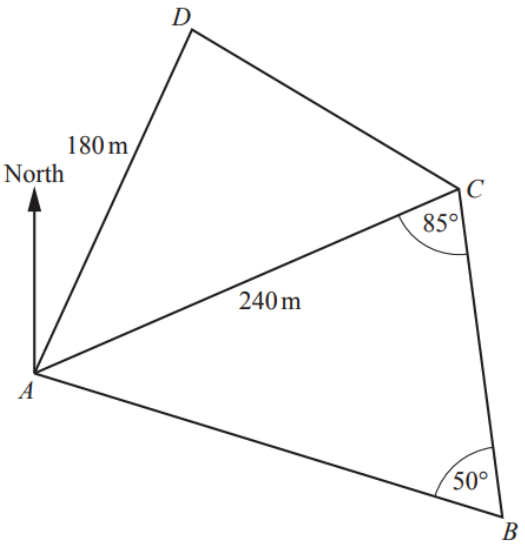
NOT TO SCALE

The perimeter of the isosceles triangle is $2q + q\sqrt{3}$ centimetres.

Find the value of y.

$y =$ ..... [4]

3



NOT TO SCALE

The diagram shows a field, $ABCD$.
$AD = 180$ m and $AC = 240$ m.
Angle $ABC = 50°$ and angle $ACB = 85°$.

(a) Use the sine rule to calculate AB.

$AB =$ ..... m [3]

(b) The area of triangle $ACD = 12\,000\,\text{m}^2$.

Show that angle $CAD = 33.75°$, correct to 2 decimal places.

[3]

(c) Calculate BD.

$BD =$ ..... m [5]

(d) The bearing of D from A is 030°.

Find the bearing of

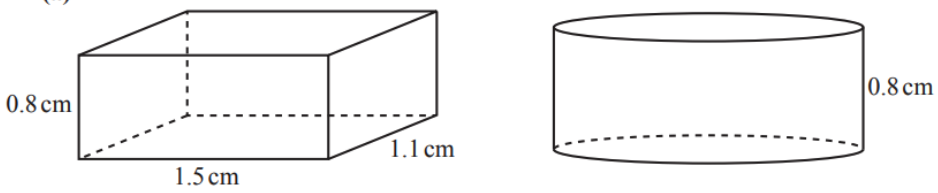
(i) B from A,

..... [1]

(ii) A from B.

..... [2]

6 **(a)**



NOT TO SCALE

The diagram shows two sweets.
The cuboid has length 1.5 cm, width 1.1 cm and height 0.8 cm.
The cylinder has height 0.8 cm and the same volume as the cuboid.

(i) Calculate the volume of the cuboid.

.....cm^3 [2]

(ii) Calculate the radius of the cylinder.

..... cm [2]

(iii) Calculate the difference between the surface areas of the two sweets.

.....cm^2 [5]

(b) A bag of sweets contains x orange sweets and y lemon sweets.
Each orange sweet costs 2 cents and each lemon sweet costs 3 cents.

The cost of a bag of sweets is less than 24 cents.
There are at least 9 sweets in each bag.
There are at least 2 lemon sweets in each bag.

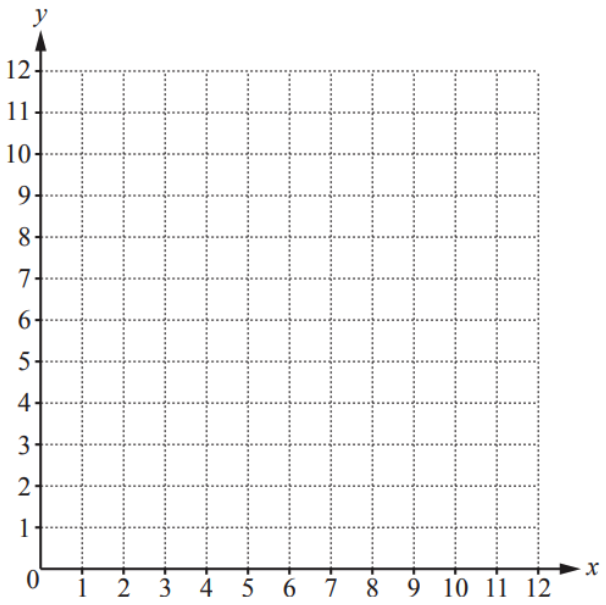
(i) One of the inequalities that shows this information is $2x+3y < 24$.

Write down the other two inequalities.

.....

..... [2]

(ii) On the grid, by shading the unwanted regions, show the region which satisfies the three inequalities.



[4]

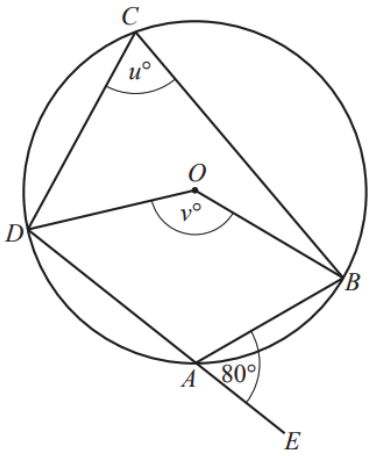
(iii) Find the lowest cost of a bag of sweets.
Write down the value of x and the value of y that give this cost.

Lowest cost = ... cents

x = ...

y = ... [3]

8 **(a)**



NOT TO SCALE

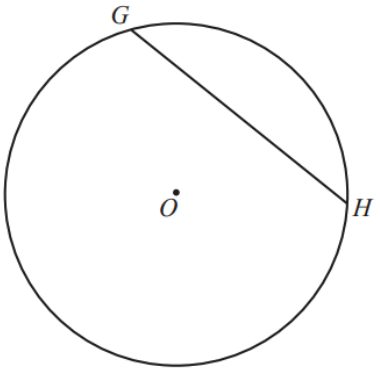
A, B, C and D lie on the circle, centre O.
DAE is a straight line.

Find the value of u and the value of v.

u = ...

v = ... [2]

(b)



NOT TO SCALE

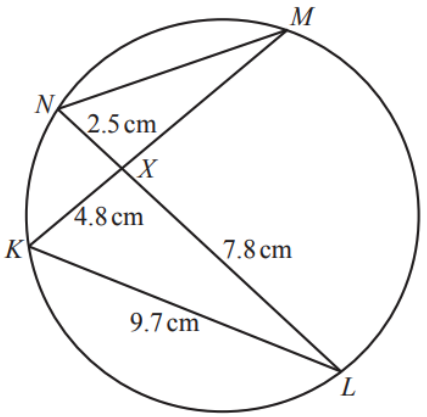
The diagram shows a circle, centre O, radius 8 cm.
GH is a chord of length 10 cm.

Calculate the length of the perpendicular from O to GH.

..... cm [3]

(c) *K*, *L*, *M* and *N* lie on the circle.
KM and *LN* intersect at *X*.
KL = 9.7 cm, *KX* = 4.8 cm,
LX = 7.8 cm and *NX* = 2.5 cm.

Calculate *MN*.



NOT TO SCALE

MN = ... cm [2]

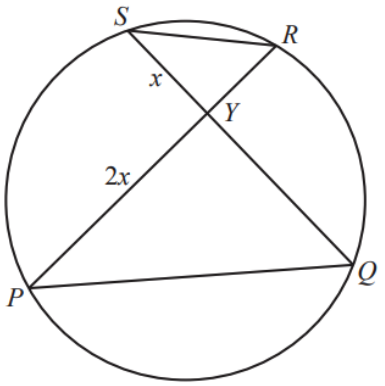
(d) All lengths are in centimetres.

P, *Q*, *R* and *S* lie on the circle.
PR and *QS* intersect at *Y*.
PY = 2*x* and *YS* = *x*.

The area of triangle $YRS = \frac{5}{12}x(x-1)$.

The area of triangle $YQP = x(x+1)$.

Find the value of *x*.



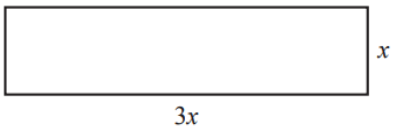
NOT TO SCALE

x = ... [4]

10 The **perimeter** of each of the three shapes is 60 cm.

Find x in each part.

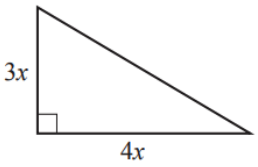
(a) Rectangle



NOT TO SCALE

x = ... cm [2]

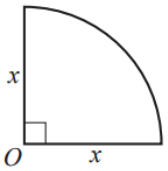
(b) Triangle



NOT TO SCALE

x = ... cm [3]

(c) Sector



NOT TO SCALE

x = ... cm [3]

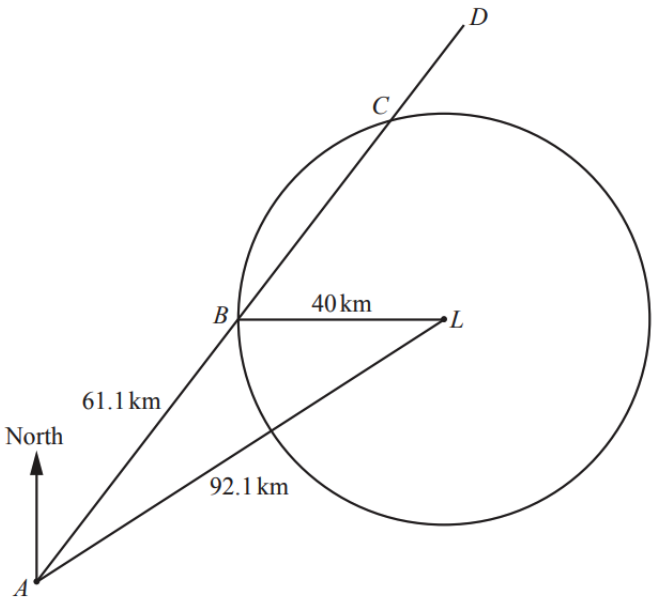
(c) Betty takes a photograph of the completed puzzle.
The photograph and the completed puzzle are mathematically similar.

The area of the photograph is 875 cm^2 and the area of the puzzle is 2835 cm^2.
The length of the photograph is 35 cm.

Work out the length of the puzzle.

..... cm [3]

6



NOT TO SCALE

The diagram shows the position of a port, A, and a lighthouse, L.
The circle, centre L and radius 40 km, shows the region where the light from the lighthouse can be seen.
The straight line, $ABCD$, represents the course taken by a ship after leaving the port.
When the ship reaches position B it is due west of the lighthouse.

$AL = 92.1$ km, $AB = 61.1$ km and $BL = 40$ km.

(a) Use the cosine rule to show that angle $ABL = 130.1°$, correct to 1 decimal place.

[4]

(b) Calculate the bearing of the lighthouse, L, from the port, A.

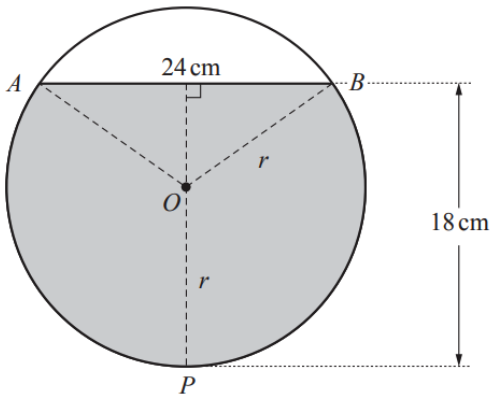
..... [4]

(c) The ship sails at a speed of 28 km/h.

Calculate the length of time for which the light from the lighthouse can be seen from the ship.
Give your answer correct to the nearest minute.

..... h ..... min [5]

8



NOT TO SCALE

The diagram shows the cross section of a cylinder, centre O, radius r, lying on its side.
The cylinder contains water to a depth of 18 cm.
The width, AB, of the surface of the water is 24 cm.

(a) Use an algebraic method to show that $r = 13$ cm.

[4]

(b) Show that angle $AOB = 134.8°$, correct to 1 decimal place.

[2]

(c) **(i)** Calculate the area of the major sector $OAPB$.

.....cm^2 [3]

(ii) Calculate the area of the shaded segment APB.

.....cm^2 [3]

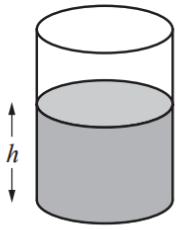
(iii) The length of the cylinder is 40 cm.

Calculate the volume of water in the cylinder.

.....cm^3 [1]

(d) The cylinder is turned so that it stands on one of its circular ends.
In this position, the depth of the water is h.

Find h.



NOT TO SCALE

h = ... cm [2]

Mathematics

Paper 4

Geometry
Mensuration
Trigonometry

ANSWERS

3(a)	187	**2**	**M1** for $220 \times \left(1 - \frac{15}{100}\right)$ oe or **B1** for 33 seen
3(b)	19.8	**3**	**M2** for $29.7 \times \sqrt[3]{\frac{0.4}{1.35}}$ oe or **M1** for $\sqrt[3]{\frac{0.4}{1.35}}$ or $\sqrt[3]{\frac{1.35}{0.4}}$ oe seen or for $\frac{29.7^3}{x^3} = \frac{1.35}{0.4}$ oe
3(c)	12.4 or 12.44…	**3**	**M1** for $90 \times 75 \times h = 7 \times$ figs 12 **B1** for 1000 cm^3 = 1 litre soi

4(a)	32.9 or 32.91 to 32.92…	**2**	**M1** for $\pi \times 1.65 \times 4.7 + \pi \times 1.65^2$
4(b)	69.4 or 69.44 to 69.45	**2**	**M1** for cos = $1.65 \div 4.7$ oe
4(c)(i)	12.5 or 12.54 to 12.55	**4**	**M3** for $\frac{1}{3} \times \pi \times 1.65^2 \times \sqrt{4.7^2 - 1.65^2}$ oe or **M2** for $\sqrt{4.7^2 - 1.65^2}$ oe or for $4.7 \times \sin(\textit{their}$ **(b)**$)$ oe or **M1** for $1.65^2 + h^2 = 4.7^2$ oe or for $\frac{h}{4.7} = \sin(\textit{their}$ **(b)**$)$ oe
4(c)(ii)	41 nfww	**4**	**B3** for 41.7… to 41.9 or **M2** for $\frac{4}{3} \times \pi \times 5^3 \div$ *their* 12.5 or **M1** for $\frac{4}{3} \times \pi \times 5^3$ After **M2** scored, **M1** for truncating *their* decimal number of cones seen to an integer answer

8(a)(i)	2.67 or 2.666…	**3**	**M2** for $\frac{6\times\sin 25}{\sin 72}$ or **M1** for implicit version
8(a)(ii)	4.14 or 4.140…	**3**	**M1** for $6^2+7.4^2-2\times6\times7.4\times\cos 34$ **A1** for 17.1 to 17.2
8(a)(iii)	20.4 or 20.35 to 20.36…	**4**	**B1** for angle $SQR = 83$ **M1** for $\frac{1}{2}\times 6\times$ *their* **(a)(i)** $\times \sin$ *their* (180–72–25) oe **M1** for $\frac{1}{2}\times 6\times 7.4\times\sin 34$ oe
8(b)(i)	8.7[0] or 8.695…	**4**	**B3** for $\sqrt{980}$ oe or 31.3 or 31.30… or **M3** for $40-\sqrt{20^2+18^2+16^2}$ oe or **M2** for $20^2+18^2+16^2$ oe or **M1** for any correct attempt at 2-dimensional Pythagoras' e.g. 18^2+16^2
8(b)(ii)	30.7 or 30.73 to 30.74…	**3**	**M2** for [sin =] $\frac{16}{\sqrt{20^2+18^2+16^2}}$ oe or **B1** for identifying angle *GAC*

7(a)	[BC^2 =] $80^2+115^2-2\times80\times115\cos 72$ oe	**M1**	
	118.06…	**A2**	**A1** for 13939…

7(b)	67.8 or 67.9 or 67.83 to 67.88	**3**	**M2** for [sin B =] $\frac{115\times\sin 72}{118.1}$ oe or **M1** for $\frac{115}{\sin B}=\frac{118.1}{\sin 72}$ oe
7(c)(i)	255	**3**	**B1** for bearing of B from A is 75 soi **M1** for 180 + 75 oe
7(c)(ii)	[00]7.2	**2**	**M1** for *their* **(c)(i)** – *their* **(b)** –180
7(d)	11.8 or 11.82 to 11.83	**3**	**M1** for 115 ÷ 35 oe **M1** for *their* speed in m/s × 60 × 60 ÷ 1000
7(e)	76.1 or 76.08 to 76.09	**3**	**M2** for $\frac{\text{distance}}{80}=\sin 72$ oe or **M1** for distance required is perpendicular to AC soi

9(a)	39[.0] or 39.03 to 39.04…	**3**	**M2** for $\frac{165}{360}\times 2\times\pi\times 8+16$ or **M1** for $\frac{165}{360}\times 2\times\pi\times 8$
9(b)	2.71 or 2.708…	**4**	**M3** for $\sqrt{\frac{\frac{165}{360}[\times\pi]\times 8^2}{4[\times\pi]}}$ oe or **M2** for $r^2=\frac{\frac{165}{360}[\times\pi]\times 8^2}{4[\times\pi]}$ oe or **M1** for $\frac{165}{360}\times\pi\times 8^2$ oe seen

9(c)(i)	3.67 or 3.666 to 3.667	**2**	**M1** for $\frac{165}{360}\times 2[\times\pi]\times 8=2[\times\pi]\times r$ or better or for $\frac{165}{360}[\times\pi]\times 8^2=[\pi\times]r\times 8$ or better
9(c)(ii)	100 or 100.0 to 100.1… final answer	**4**	**M3** for $\frac{1}{3}\pi\times their(c)(i)^2\times\sqrt{8^2-their\,\text{radius}^2}$ or **M2** for $\sqrt{8^2-their\,\text{radius}^2}$ or **M1** for $(their\ (c)(i))^2+h^2=8^2$

4(a)	65.4 or 65.36 to 65.37	**3**	**M1** for $150^2+120^2-2\times 150\times 120\cos 25$ **A1** for 4270 or 4272 to 4273
4(b)	125 or 124.7 to 124.8	**4**	**B1** for [angle S =] 80 **M2** for $\frac{150\sin 55}{\sin their 80}$ or **M1** for $\frac{\sin their 80}{150}=\frac{\sin 55}{RS}$ oe
4(c)	10 400 or 10 410 to 10 440 nfww	**3**	**M1** for $\frac{1}{2}\times 120\times 150\sin 25$ oe **M1** for $\frac{1}{2}\times 150\times their$ **(b)**$\sin 45$ oe

5(a)	[0]38 or [0]37.9 or [0]37.87...	**2**	**M1** for tan = $\frac{350}{450}$ oe If 0 scored, **SC1** for answer [0]52 or [0]52.1 or [0]52.12 to [0]52.13
5(b)	624 or 623.8 to 623.9	**6**	**M2** for 450 – 400 sin 50 or **M1** for sin 50 = $\frac{\ldots}{400}$ **M2** for 350 + 400 cos 50 or **M1** for cos 50 = $\frac{\ldots}{400}$ **M1** for (*their* (450 – 400 sin 50))^2 + (*their* (350 + 400 cos 50))^2
5(c)	10 min 8 s	**4**	**B3** for 10.1 or 10.13… or **M2** for (400 + 350 + 450 + *their DA*) ÷ 3 [÷ 60] oe or **M1** for any distance ÷ 3 **M1** for rounding *their* minutes into minutes and seconds to nearest second if clearly seen
8(a)(i)	36	**2**	**M1** for $\left(\frac{8}{12}\right)^2$ or $\left(\frac{12}{8}\right)^2$ oe
8(a)(ii)	30	**3**	**M2** for $320 \div 16 \times \frac{12}{8}$ oe or **M1** for $320 \div 16$
8(b)	3.375 cao	**3**	**M2** for $\frac{\frac{4}{3}\pi \times 4.5^3}{\pi \times 6^2}$ or better or **M1** for $\pi \times 6^2 \times h = \frac{4}{3} \times \pi \times 4.5^3$
8(c)	3.63 or 3.627 to 3.628	**3**	**M2** for $\frac{20^3}{40 \times \frac{4}{3}\pi}$ or **M1** for $40 \times \frac{4}{3} \times \pi \times r^3 = 20^3$
8(d)	$\frac{3x}{2}$ or $1.5x$ or $1\frac{1}{2}x$	**3**	**B2** for $4R^2 = 9x^2$ oe or better or **M1** for $4\pi R^2 = 2\pi x^2 + \pi \times 2x \times \frac{7x}{2}$

5(a)	$(4x-5)(x+3)+(x+1)(x-3)=342$ or $2x(4x-5)-(3x-6)(x-3)=342$	**M2**	**M1** for $(4x-5)(x+3)$ or $(x+1)(x-3)$ or for $2x(4x-5)$ or $(3x-6)(x-3)$
	$4x^2+12x-5x-15$ oe and $x^2+x-3x-3$ oe seen OR $8x^2-10x$ and $3x^2-15x+18$ seen	**M2**	**M1** for each
	$5x^2+5x-18=342$ leading to $x^2+x-72=0$	**A1**	no errors or omission
5(b)	$(x+9)(x-8)$	**M2**	**B1** for $(x+a)(x+b)$ where $ab=-72$ or $a+b=1$ and a, b are integers
	8, –9	**B1**	
5(c)	86	**2**	**FT** for $12\times$*their* $x-10$ (x positive) **B1** for any one of 27, 11, 16 seen or for $2x+2x+4x-5+4x-5$ oe or better soi
5(d)	22.2 or 22.16 to 22.17	**2**	**M1** for tan = $\frac{11}{27}$ or $\frac{\textit{their}\ x+3}{4\times\textit{their}\ x-5}$

6(a)(i)	29.5 or 29.50…	**4**	**M2** for $\frac{11^2+5.3^2-6.9^2}{2\times11\times5.3}$ or **M1** for $6.9^2 = 11^2 + 5.3^2 - 2\times11\times5.3\cos x$ **A1** for 0.87[0…] oe
6(a)(ii)	13.4 or 13.38…	**4**	**B1FT** 84 – *their* (***a***)**(i)** **M2** for $\frac{11}{\sin 42}\times\sin$ *their* 54.5 or **M1** for implicit form
6(b)	2700	**4**	**M2** for $15\times2.5\times20\times60\times60$ or **M1** for $15\times2.5\times20$ **M1** for *their* volume ÷ 1000 If 0 scored, **SC1** for figs 27 with no working

8(a)	12	**2**	**M1** for $150 = \frac{(n-2)\times 180}{n}$ or $\frac{360}{180-150}$ oe
8(b)(i)	45	**2**	**B1** for angles at M or $K = 45$ or angle at $L = 90$
8(b)(ii)	85	**2**	**B1** for either angle in alt segment = 58
8(b)(iii)	72	**2**	**B1** for either angle at J or H=108 or angle at F=72
8(c)	$OA = OB = OC = OD$ Radii	**B1**	
	$AB = CD$ chords equidistant from centre are equal	**B1**	
	SSS implies congruent	**B1**	

4(a)	38.6	**3**	**M2** for [2 ×] (8.5 + 0.05 + 10.7 + 0.05) or **M1** for 8.5 + 0.05 or 10.7 + 0.05
4(b)(i)	8.86 or 8.863…	**2**	**M1** for $\frac{h}{9}$ = sin 80 or better oe
4(b)(ii)	∠CDF = 100 leading to $\angle DCF = 40$ Or ∠EDF = 80 leading to $\angle DCF = 40$	**M1**	Implied by 180-(100 + 40) = 40 or 80 – 40
	'two equal angles'	**A1**	With no incorrect work seen
4(b)(iii)	66.5 or 66.45 to 66.47…	**3**	**M2** for 0.5(3 + 12) × *their* **(b)(i)** or 12 × *their* **(b)(i)** – 0.5 × 9 × 9 × sin 100 oe or **B1** for $DC = 9$ or $BC = 3$

4(c)	130 nfww or 129.6 to 129.8	**5**	**B1** for $\angle ACD = 21°$ or $\angle CAD = 69°$ **Method 1** **M2** for $\cos 21 = \frac{12}{AC}$ oe or **M1** for $\angle ADC = 90$ soi **M1** for $\pi(their\ AC/2)^2$ OR **Method 2** **M2** for $\frac{12}{sin138} = \frac{r}{sin21}$ oe or **M1** for $\angle COD = 138$ soi **M1** for $\pi(their\ r)^2$ OR **Method 3** **M2** for $\cos 21 = \frac{6}{OC}$ oe or **M1** for $\angle CXO = 90$ soi where X is the point where the perpendicular from O meets the chord CD **M1** for $\pi(their\ OC)^2$
4(d)	78.4 or 78.37 to 78.41	**3**	**M2** for $\frac{x}{360} \times 2 \times \pi \times 9.5 + 2 \times 9.5 = 4 \times 8$ oe or **M1** for $\frac{x}{360} \times 2 \times \pi \times 9.5$ After **M0, SC1** for $9.5x + 19 = 32$ oe

6(a)(i)	106.01 to 106.02	**4**	**M2** for $[\cos[\angle CBD] =] \dfrac{192^2 + 168^2 - 287.9^2}{2\times192\times168}$ oe or **M1** for the implicit form **A1** for –0.276 to – 0.275
6(a)(ii)	292.0 or 291.98 to 291.99	**1**	
6(a)(iii)	310.0 or 310.03 to 310.04	**5**	**M2** for $[\sin A =] \dfrac{168\times\sin(90-38)}{205.8}$ or **M1** for $\dfrac{\sin A}{168} = \dfrac{\sin(90-38)}{205.8}$ **A1** for [A =] 40.0 or 40.03 to 40.04 **M1 dep** for 270 + *their* angle DAB oe
6(b)(i)	15 500 or 15 501 to 15 503. …	**2**	**M1** for $0.5 \times 192 \times 168 \times \sin(106)$ oe
6(b)(ii)	55 400	**2**	**FT** $3.575 \times$ *their* **(b)(i)** oe rounded to nearest 100 **M1** for figs 35 75 × figs *their* **(b)(i)** or figs 554 or figs 5541 to figs 5543

8(a)	[v =] 40 [w =] 80 [x =] 40 [y =] 100 [z =] 60	**5**	**B1** for each **FT** angle z as 140 – *their w*
8(b)	24	**3**	**M2** for $360 - 11x = 2 \times 2x$ oe or **M1** for $360 - 11x$ seen or obtuse angle $KOL = 2 \times 2x$ oe
8(c)(i)	angle ADX = angle BCX oe same segment oe angle DAX = angle CBX oe same segment oe angle AXD = BXC oe [vertically] opposite oe	**M2**	Accept in any order **M1** for one correct pair with reason If 0 scored, **SC1** for two correct pairs of equal angles identified with incorrect/no reasons
	corresponding angles are equal oe	**A1**	
8(c)(ii)(a)	8.75 or 8¾	**2**	**M1** for $\dfrac{8}{10} = \dfrac{7}{DX}$ oe
8(c)(ii)(b)	81.8 or 81.78 to 81.79	**4**	**M2** for $[\cos[BXC] =] \dfrac{5^2 + 7^2 - 8^2}{2\times5\times7}$ oe or **M1** for $8^2 = 5^2 + 7^2 - 2\times5\times7\times\cos(...)$ oe **A1** for $\dfrac{10}{70}$ oe

9(a)	315 or 314.5 to 315.0	**6**	**M1** for $\tan 70 = \dfrac{\text{height}}{\frac{1}{2}(8-5)}$ oe or better seen **M1dep** for $\frac{1}{2}(8+5)\times$ *their* height or better seen **dep** on trig attempt for height **M2** for $12 \times \dfrac{\frac{1}{2}(8-5)}{\cos 70}$ oe or better seen or **M1** for $\dfrac{\frac{1}{2}(8-5)}{\cos 70}$ oe or better seen **M1** for 8×12 oe isw and 5×12 oe isw
9(b)(i)	8 – ½ (8 – 5) or 5 + ½ (8 – 5)	**M1**	
9(b)(ii)	13.6 or 13.64 to 13.65	**2**	**M1** for $12^2 + (6.5)^2$ oe
9(b)(iii)	16.8 or 16.9 or 16.79 to 16.91… nfww	**2**	**M1** for identifying angle *GAX* from a diagram or from working or better

5(a)(i)	81° Angle at centre is twice angle at circumference oe	**2**	**B1** for 81°
5(a)(ii)	81° Alternate segment [theorem] oe	**2**	**FT** *their* **(a)(i)** **B1FT** for 81°

5(a)(iii)	123° Angles on a straight line [= 180] Opposite angles in a cyclic quadrilateral are supplementary oe	**3**	**FT** *their* acute **(a)(ii)** + 42 **B1** for each element
5(b)(i)	Angle *PTU* = angle *PRQ* corresponding Angle *PUT* = angle *PQR* corresponding Angle *RPQ* is common oe	**M2**	Accept in any order **M1** for one correct pair with reason If 0 scored, **SC1** for two correct pairs of equal angles identified with incorrect/no reasons
	Corresponding angles are equal oe	**A1**	
5(b)(ii)(a)	4 : 7 oe	**1**	
5(b)(ii)(b)	41.25 oe	**3**	**M2** for $20\times\left(\frac{7}{4}\right)^2$ oe or $20\times\frac{7^2-4^2}{4^2}$ oe or **M1** for $\left(\frac{7}{4}\right)^2$ or $\left(\frac{4}{7}\right)^2$ or $\frac{7^2-4^2}{4^2}$ or $\frac{4^2}{7^2-4^2}$
6(a)	440	**2**	**M1** for $8\times5\times11$
6(b)	$\sqrt{8^2+5^2+11^2}$ oe or $8^2 + 5^2 + 11^2$ and 13^2 ALTERNATIVE $\sqrt{8^2+11^2}$ or $8^2 + 11^2$ and 13^2	**M3**	**M2** for $8^2 + 5^2 + 11^2$ or $8^2 + 11^2$ oe or **M1** for $8^2 + 5^2$ or $5^2 + 11^2$ oe
	Yes and 14.5 or 14.4 or 14.49… or Yes and 13.6[0…]	**A1**	Accept equivalent conclusion
6(c)(i)	32.0[…]	**2**	**M1** for tan[..] = $\frac{5}{8}$ oe
6(c)(ii)	49.4 or 49.38 to 49.39	**2**	**M1** for sin[..] = $\frac{11}{\textit{their AG}}$ oe

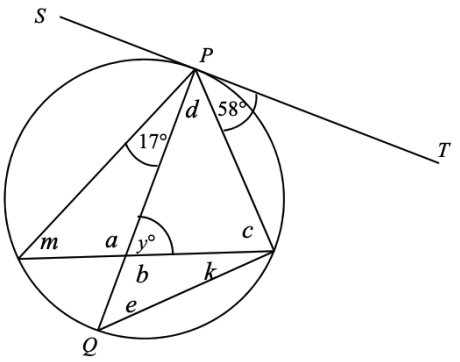
4(a)	Correct ruled line with *D* marked	**2**	**B1** for correct ruled line or short line
4(b)	47.5	**2**	**B1** for 9.5 or 95 mm seen or for answer figs 465 to figs 485
4(c)	Correct arc radius 7 cm	**2**	**B1** for complete arc other radius, centre *A* or correct but short arc
	Correct ruled perpendicular bisector of *BC* with correct pairs of arcs	**2**	**B1** for correct perpendicular bisector without correct arcs or for correct arcs, no/incorrect line
	Correct ruled bisector of angle *BCD* with correct pairs of arcs	**2**	**B1** for correct angle bisector without correct arcs or for correct arcs, no/incorrect line
	correct region shaded	**1**	Dep on at least **B1B1B1** and five boundaries one of which is an arc
4(d)	[1 :] 500	**1**	

6(a)	5.83 or 5.832 to 5.833	**5**	**B2** for sector angle = 210 soi or **M1** for $[\cos DOE =]\frac{0.25}{0.5}$ oe **M2** for $\frac{their210}{360}\times 2\times\pi\times 0.5+2\times 1.5+2\times 0.5$ oe or **M1** for $\frac{their210}{360}\times 2\times\pi\times 0.5$ oe isw
6(b)	1.21 or 1.208…	**3**	**M2** for $\frac{their210}{360}\times\pi\times 0.5\times 0.5+1.5\times 0.5$ oe or **M1** for $\frac{their210}{360}\times\pi\times 0.5\times 0.5$ oe isw
6(c)(i)	4[.00...]	**3**	**M2** for $0.5\times\sqrt{\frac{77.44}{their(\mathbf{b})}}$ oe or **M1** for $\sqrt{\frac{77.44}{their(\mathbf{b})}}$ or $\sqrt{\frac{their(\mathbf{b})}{77.44}}$ or for $\frac{their(\mathbf{b})}{77.44}=\frac{0.5^2}{r^2}$ oe
6(c)(ii)	2.20704	**3**	**M2** for 77.44 × 1.5 × 19 ÷ 1000 oe or **M1** for figs 2207[04] or figs 221 seen or [vol =] 77.44 × 1.5

3(a)	530	**4**	**B3** for $[DE] = 130$ m and $[DC] = 80$ m or **B2** for $[DE] = 130$ m or $[DC] = 80$ m or **M1** for $50^2 + 120^2$ or $170^2 - 150^2$
3(b)	52.9 or 52.89…	**4**	**M2** for $\frac{100^2 + 150^2 - 120^2}{2 \times 100 \times 150}$ or **M1** for $120^2 = 100^2 + 150^2 - 2 \times 100 \times 150\cos(\ldots)$ **A1** for 0.603 or 0.6033…or $\frac{181}{300}$
3(c)(i)	28.1 or 28.07…	**2**	**M1** for $\cos = \frac{15}{17}$ oe
3(c)(ii)	331.9 or 331.9…	**2**	**FT** 360 – *their* **(c)(i)** **M1** for 360 – *their* **(c)(i)** oe
3(d)	1.5[0] or 1.498… nfww	**4**	**M1** for $\frac{1}{2} \times 50 \times 120$ oe **M1** for $\frac{1}{2} \times 100 \times 150 \sin(\textit{their}\textbf{(b)})$ oe **M1** for $\frac{1}{2} \times 150 \times \textit{their}CD$ oe or $\frac{1}{2} \times 150 \times 170 \times \sin \textit{their}\textbf{(c)(i)}$ If 0 scored, **SC1** for dividing *their* area by 10 000
5(a)	4.73 or 4.730 to 4.731...	**3**	**M2** for $3 \times 1.2 + \pi \times 0.6^2$ oe or **M1** for $\pi \times 0.6^2$ or $\frac{1}{2} \times \pi \times 0.6^2$ or 3×1.2
5(b)	946 or 946.0 to 946.2...	**3**	**M2** for *their* **(a)** × 0.2 × 1000 oe or **M1** for *their* **(a)** × 0.2 or 20 implied by figs 946[0] to 9462
5(c)	1.28 or 1.29 or 1.284 to 1.290	**3**	**M2** for $\frac{(1007 - \textit{their}\textbf{(b)}) \div 1000}{\textit{their}\textbf{(a)}} \times 100$ oe or for $\frac{1007 - \textit{their}(\mathbf{b})}{\textit{their}(\mathbf{b})} \times 20$ oe or **M1** for figs $\frac{1007 - \textit{their}(\mathbf{b})}{\textit{their}(\mathbf{a})}$ or figs $\frac{1007}{\textit{their}(\mathbf{a})}$ or for $\frac{1007 - \textit{their}(\mathbf{b})}{\textit{their}(\mathbf{b})}$ or $\frac{1007}{\textit{their}(\mathbf{b})} \times 20$ oe

10(a)	10	**1**	
10(b)	6.2[0] or 6.203 to 6.204	**3**	**M2** for $[x^3=]\ 1000 \div \frac{4}{3}\pi$ oe or better or **M1** for $\frac{4}{3}\pi x^3 = 1000$
10(c)	7.82 or 7.815 to 7.816	**4**	**B3** for $[x^3 =]1000 \div \frac{1}{3}\pi \div 2$ oe or better or **M1** for $\left(x\sqrt{5}\right)^2 - x^2$ soi by $4x^2$ or $2x$ **M1dep** for $\frac{1}{3}\pi \times x^2 \times$ *theirh*$[=1000]$
10(d)	$6\frac{2}{3}$ or 6.67 or 6.666 to 6.667	**4**	**B3** for $[x^3 =]1000 \div \frac{27}{8}$ oe or $\frac{3x}{2} = 10$ or better or **M2** for $\frac{1}{2} \times x \times \frac{x}{2} \times \frac{27x}{2} = 1000$ oe or **M1** for $\frac{1}{2} \times x \times \frac{x}{2}$ If 0 scored, **SC2** for answer 5.29 or 5.291..

2(a)	103	**3**	**M1** for angle *ABC* or angle *ACB* = $\frac{1}{2}(180-26)$ oe **M1** for angle *ABF* = 26 or angle *CBD* or angle *FBE* = 77 or exterior angle *ACB* = 103 correctly identified or in correct position

2(b)	75	**5**	**B4** for 105 at *a* or *b* **or** 73 at *c* **and** 32 at *d* or **B3** for 58 at *m* **or** 58 at *e* **and** 17 at *k* or **B2** for 32 at *d* **and** 90 soi at (*c*+*k*) **or** 32 at *d* **and** 17 at *k* **or** 73 at *c* or **B1** for 90 soi at (*c* + *k*) or between tangent and radius **or** 32 at *d* **or** 17 at *k* 

7(a)	$180-\frac{360}{5}$ or $\frac{(5-2)\times180}{5}$ or $\frac{(2\times5-4)\times90}{5}$ or $\frac{5\times180-360}{5}$	**M2**	or **M1** for $\frac{360}{5}$ or $(5-2)\times180$ or $90(2\times5-4)$ or $3\times180\div5$ or $6\times90\div5$ or $5\times180-360$ If 0 scored, **SC1** for $\frac{5-2\times180}{5}$
7(b)(i)	7.05 or 7.053…	**3**	**M2** for $12\times\cos54$ oe or **M1** for implicit form or **B1** for length of edge of pentagon = 14.1 to 14.11 If 0 scored, **SC1** for right angle at *M*
7(b)(ii)(a)	22.8 or 22.81 to 22.83… nfww	**3**	**M2** for $\frac{\textit{their}\,\textbf{(b)(i)}}{\cos72}$ oe or **M1** for implicit form oe or **B1** for *AX* = 36.9 or 36.93 to 36.94
7(b)(ii)(b)	179 or 179.1 to 179.3…	**3**	**M2** for $\frac{1}{2}\times12\times\textit{their}\,AX\times\sin54$ oe or $\frac{1}{2}\times12\times\textit{their}\,OX\times\sin108$ oe or $\frac{1}{2}\times\textit{their}\,AX\times\textit{their}\,OX\times\sin18$ or $\frac{1}{2}\times12^2\times\sin72+\text{area}\,OBX$ oe or $\frac{1}{2}\times12^2\times\sin72+\text{area}\,OMB+\text{area}\,MBX$ oe or **M1** for a correct method to find area of one relevant triangle *AOB*, *OMB*, *MBX*, *OBX* or *ONX* **seen**
8(a)(i)	15.7 or 15.70...	**4**	**M2** for $16.5^2+12.4^2-2\times16.5\times12.4\times\cos64$ or **M1** for implicit form **A1** for 246 to 247
8(a)(ii)	18.7 or 18.68 to 18.69	**4**	**B1** for 32 or angle *DBM* = 37 or angle *CBM* = 58 **M2** for $\frac{12.4\times\sin53}{\sin32}$ oe or **M1** for implicit form oe
8(b)(i)	116.1 or 116.08 to 116.09...	**2**	**M1** for $\frac{y}{360}\times2\times\pi\times3.8=7.7$ oe
8(b)(ii)	14.6 or 14.61 to 14.63…	**2**	**M1** for $\frac{\textit{their}\,\textbf{(b)(i)}}{360}\times\pi\times3.8^2$ oe

10(a)(i)	18[.0] or 17.99 to 18.00…	**3**	**M2** for $\sqrt[3]{\frac{24430\times 3}{4\pi}}$ oe or **M1** for $\frac{4}{3}\pi r^3 = 24430$
10(a)(ii)	447 or 446.8 to 446.9...	**3**	**M2** for $\pi\times 50^2\times 60 - 24430$ oe or **M1** for $\pi\times 50^2\times 60$ oe
10(b)	4 [hours] 30 [mins] nfww	**4**	**B3** for 16200 or 4.5 or 270 or **M2** for $\frac{\text{figs } 18\times\text{figs } 15\times\text{figs } 12}{\text{figs } 2}$ oe or **M1** for figs 18 × figs 15 × figs 12 oe
10(c)	12.5 or 12.50…	**3**	**M2** for $17\times\sqrt{\frac{159.5}{295}}$ oe or **M1** for $\sqrt{\frac{159.5}{295}}$ or $\sqrt{\frac{295}{159.5}}$ seen or for $\frac{159.5}{295} = \frac{x^2}{17^2}$ oe

4(a)(i)	$\frac{1}{2}\times\frac{4}{3}\times\pi\times5.6^3$	**M1**	
	367.8... to 367.9	**A1**	
4(a)(ii)	3.06 or 3.060 to 3.061...	**4**	**M1** for 0.8×368 [= 294.4] **M2** for $[r^2 =] \frac{\textit{their}\ 294.4}{10\pi}$ oe or **M1** for $\pi r^2 \times 10 = \textit{their}$ 294.4 oe
4(b)(i)	44[.0] or 43.98 to 43.99 nfww	**5**	**B2** for [slant height =] $\frac{25}{4}$ oe or **M1** for $[l^2 =] 6^2 + 1.75^2$ oe **M2** for $\pi\times1.75\times\textit{their}\,l+\pi\times1.75^2$ or **M1** for $\pi\times1.75\times\textit{their}\,l$ or $\pi\times1.75^2$
4(b)(ii)(a)	SF = $\frac{1}{4}$ oe soi	**B1**	
	$\frac{1}{3}\pi\times1.75^2\times6-\frac{1}{3}\pi\times\textit{their}\,0.4375^2\times1.5$ **OR** $\frac{1}{3}\pi\times1.75^2\times6\times\left(1-\left(\frac{1}{4}\right)^3\right)$ oe	**M2**	**M1** for $\frac{1}{3}\pi\times1.75^2\times6$ or $\frac{1}{3}\pi\times\textit{their}\,0.4375^2\times1.5$ **OR** **M1** for $1-\left(\frac{1}{4}\right)^3$ oe
	18.94 or 18.939 to18.944…	**A1**	
4(b)(ii)(b)	95 final answer	**3**	**B2** for 94.5 or 94.69 to 94.722 OR **M2** for $18.9\times10^3\div200$ oe or **M1** for 18.9×10^3 or $200\div10^3$ or figs 189..÷ 200 or 18.9.. ÷ figs 2

9(a)(i)	$\angle ACD = 46$ soi or $\angle CDE = 44$ soi	**B2**	**B1** for angle $ADC = 108$ or angle $DCB = 18$
	$\frac{58\sin108}{\sin\textit{their}46}$	**M2**	**M1** for $\frac{\sin108}{x}=\frac{\sin\textit{their}46}{58}$ oe
	76.68… nfww	**A1**	
9(a)(ii)	10.9 or 10.91 to 10.94	**3**	**B2** for $[AB =]$ 68.9 or 68.91 to 68.94 or **M2** for a correct explicit statement for AB or BD or **M1** for $\frac{AB}{76.7}$ = cos26 oe
9(b)(i)	10.4 or 10.43 to 10.44	**4**	**M3** for $\sqrt{\frac{70}{\sin40}}$ oe or **M2** for $x^2 \times \sin 40 = 70$ oe or **M1** for $\frac{1}{2}x \times 2x \times \sin 40 = 70$
9(b)(ii)	140	**1**	

1(a)	[p =] 132 [q =] 77	**3**	**B1** for 132 [=p] **B2** for 77 [=q] or **M1** for 180 – (55 + 48) oe or for *their* p – 55
1(b)	74	**3**	**B2** for $5x - 10 = 360$ or **M1** for $x + (x + 5) + (2x - 25) + (x + 10) = 360$ or for $5x - 10 = k$
1(c)	175	**3**	**M2** for $180 - \frac{360}{72}$ or for $\frac{180(72-2)}{72}$ or **M1** for $\frac{360}{72}$ or for 180 (72 – 2)
1(d)	[u =] 30 [v =] 60 [w =] 60 [x =] 120 [y =] 40	**6**	**B1** for 30 **B1** for 60 **B1** for 60 FT *their v* **B1** for 120 FT 2 × *their w* **B2** for 40 or **B1** for angle $BDC = 20$ or angle $ADO = 30$ or angle $ADB = 70$
1(e)	26	**4**	**B3** for $360 - 22 = 10x + 3x$ oe or better or for $5x + 1.5x = 180 - 11$ oe or better or **M2** for $360 - (3x + 22) = 2 \times 5x$ oe or for $5x + \frac{1}{2}(3x + 22) = 180$ oe or **SC2** for $360 + 22 = 10x + 3x$ oe or better or **M1** for $180 - 5x$, $10x$ or $360 - (3x + 22)$ correctly placed on the diagram or identified or for angle A + angle $C = 5x$

4(a)(i)	955 or 955.0 to 955.2	**2**	**M1** for $2 \times \pi \times 8 \times 19$ oe
4(a)(ii)	812 or 811.7 to 811.9...	**2**	**FT** *their* (i) × 0.85 **M1** for *their* (i) × 0.85 or *their* (i) × 85
4(b)(i)	$\frac{\frac{4}{3} \times \pi \times 6^3}{\frac{1}{3} \times \pi \times 8^2}$ or cancelling clearly seen to reach 13.5	**M2**	**M1** for $\frac{4}{3} \times \pi \times 6^3 = \frac{1}{3} \times \pi \times 8^2 \times h$
4(b)(ii)	15.7 or 15.69...	**2**	**M1** for $8^2 + 13.5^2$ or better
4(b)(iii)	394 or 395 or 394.3 to 394.6...	**1**	**FT** $\pi \times 8 \times$ *their* (b)(ii)

4(c)	567	**3**	**M2** for $\frac{168}{V} = \left(\frac{80}{180}\right)^{\frac{3}{2}}$ oe or better or **M1** for $\left(\frac{180}{80}\right)^{\frac{1}{2}}$ or $\left(\frac{80}{180}\right)^{\frac{1}{2}}$ oe seen or better
4(d)	51.3 or 51.34...	**3**	**M2** for $\tan = \frac{5}{4}$ oe or **M1** for recognition of angle *PBX*
5(a)	4.29 or 4.285 to 4.286	**3**	**M2** for $\frac{150}{\frac{450}{3.6} - \frac{120}{4} - \frac{180}{3}}$ or **M1** for [time =] 120 ÷ 4 or 180 ÷ 3 or 450 ÷ 3.6 or $3.6 = \frac{150+180+120}{\text{total time}}$
5(b)	82.8 or 82.81 to 82.82 using cosine rule	**4**	**M2** for $\frac{150^2 + 120^2 - 180^2}{2 \times 150 \times 120}$ or **M1** for $180^2 = 120^2 + 150^2 - 2 \times 120 \times 150 \cos(...)$ **A1** for $\frac{4500}{36000}$ oe
5(c)(i)	127.2 or 127.1 to 127.2 or 127	**1**	**FT** 210 – *their* (b)
5(c)(ii)	307.2 or 307.1 to 307.2 or 307	**2**	**FT** 180 + *their*(c)(i) **M1** for 180 + *their* (c)(i)
5(d)	15 or 14.99 to 15.04	**2**	**M1** for $\cos(\textit{their}\ (b)) = \frac{\text{dist}}{120}$ oe

4(a)	452 or 452.2 to 452.4…	**2**	**M1** for $\left[\frac{1}{2}\times\right]\frac{4}{3}\times\pi\times6^3$
	cm^3	**1**	
4(b)(i)(a)	400 or 399.6 to 399.9	**6**	**B3** for $[CD =]\ \sqrt{72.96}$ or [angle CBD =] 58.7 or 58.66 to 58.67 or **M2** for $\sqrt{10^2-5.2^2}$ oe or $[CBD =]\ \cos^{-1}\left(\frac{5.2}{10}\right)$ oe or **M1** for $(CD)^2 + 5.2^2 = 10^2$ oe or $\cos[CBD] = \frac{5.2}{10}$ oe or $\sin[CDB] = \frac{5.2}{10}$ oe **M1dep** for $\frac{5.2\times \textit{their } CD}{2}$ oe or $\frac{1}{2}\times 5.2\times 10\times\sin(\textit{their } CBD)$ oe **M1** for *their* area × 18 oe
4(b)(i)(b)	14.6 or 14.62 to 14.63…	**4**	**M3** for $\sin BEC = \frac{5.2}{\sqrt{10^2+18^2}}$ oe or **M2** for $[BE=]\ \sqrt{10^2+18^2}$ oe seen or $[EC =]\ \sqrt{18^2+10^2-5.2^2}$ oe seen or **M1** for $[BE^2 =]\ 10^2 + 18^2$ oe seen or $[EC^2=]\ 18^2 + 10^2 - 5.2^2$ seen
4(b)(ii)	125 or 124.9 to 125.0…	**3**	**B2** for 55[.0…] seen or **M2** for $180 - \tan^{-1}\left(\frac{10}{7}\right)$ oe or $\cos EGB = \frac{11^2+(10^2+7^2)-(10^2+18)^2}{2\times11\times\sqrt{10^2+7^2}}$ oe or **M1** for $\tan[\ \ ] = \left(\frac{10}{7}\right)$ oe or for $(10^2+18^2) = 11^2 + (10^2+7^2) - 2\times11\times$ $\sqrt{10^2+7^2}\ \cos EGB$ oe

6(a)(i)	13.9[0…] from cosine rule	**4**	**M2** for $8^2 + 13^2 - 2 \times 8 \times 13\cos 79$ or **M1** for $\cos 79 = \frac{13^2 + 8^2 - BC^2}{2 \times 8 \times 13}$ **A1** for 193 ....
6(a)(ii)	66.6 or 66.60… to 66.65 from sine rule	**3**	**M2** for [sin ACB =] $\frac{13 \times \sin 79}{their(a)(i)}$ or **M1** for $\frac{\sin ACB}{13} = \frac{\sin 79}{their(a)(i)}$ oe
6(b)(i)	$\frac{1}{2}(x+4)(4x-5)\sin 30 = 70$	**M1**	
	$4x^2 + 16x - 5x - 20 = 280$	**M2**	**Dep on M1** **B1** for $4x^2 + 16x - 5x - 20$ or better
	Leading to $4x^2 + 11x - 300 = 0$	**A1**	with no errors or omissions seen
6(b)(ii)	$\frac{-11 \pm \sqrt{11^2 - 4 \times 4 \times -300}}{2 \times 4}$	**B2**	**B1** for $\sqrt{11^2 - 4(4)(-300)}$ or better or for $\frac{-11 + \sqrt{q}}{2 \times 4}$ or $\frac{-11 - \sqrt{q}}{2 \times 4}$
	–10.14 and 7.39	**B2**	**B1** for each or **SC1** for final answers –10.1 or –10.144 to –10.143 **and** 7.4 or 7.393 to 7.394 or –10.14 **and** 7.39 seen in working or for –7.39 **and** 10.14 as final answer
6(b)(iii)	11.4 or 11.39…	**1**	**FT** *their* positive root + 4

2(a)(i)	$2a + a + 2b + 3b + 10 = 180$ leading to $3a + 5b = 170$ without error or omission	**1**	
2(a)(ii)	$8a + 3a + 2b + b + 50 + 4b - 2a = 360$ leading to $9a + 7b = 310$ without error or omission	**1**	
2(a)(iii)	Correct method to eliminate one variable	**M1**	
	[a =]15 [b=]25	**A2**	**A1** for each correct value If 0 scored, **SC1** for two values that satisfy one of the equations or for two correct answers with no/incorrect working
2(a)(iv)	30	**1**	

4(a)	36.8 or 36.84…	**2**	**M1** for $\frac{h}{107}=\tan 19$ or $\frac{h}{\sin 19}=\frac{107}{\sin 71}$ oe or better
4(b)	42.1 or 42.12… from cosine rule	**4**	**M2** for $[\cos BAC =]\frac{158^2+132^2-107^2}{2\times 158\times 132}$ or **M1** for implicit version **A1** for $[\cos BAC =]\frac{30939}{41712}$ or 0.7417…
4(c)	35.8 or 35.84… from sine rule	**3**	**M2** for $\frac{86\times\sin 116}{132}[=0.58557...]$ or **M1** for $\frac{\sin CAD}{86}=\frac{\sin 116}{132}$ oe
4(d)	9670 or 9669 to 9676	**3**	**M2** for $\frac{1}{2}\times 158\times 132\times\sin(their\ (b))$ oe and $\frac{1}{2}\times 86\times 132\times\sin(64-their\ (c))$ oe or **M1** for either area
4(e)	214.2 or 214.1… or 214	**2**	**M1** for [180 +]70–*their* (c) oe

6(a)(i)	Angle ABC=52 nfww	**B1**	ALTERNATIVE [Reflex] angle AOC = 256
	Opposite angles in cyclic quad oe Angles in opposite segments	**B1**	Angle at centre=2 × angle at circumference/arc
	[Angle AOC=104] Angle at centre=2 × angle at circumference/arc nfww	**B1**	Angles around a point
6(a)(ii)	22 nfww	**2**	**B1** for angle OAC = 38 or angle CAD = 24
6(a)(iii)	28	**1**	
6(a)(iv)	36.6 or 36.62 to 36.63 nfww	**3**	**B2** for 7.4 or 17.42 to 17.43 or **M2** for $9.6\times2+\frac{104}{360}\times2\times\pi\times9.6$ or **M1** for $\frac{104}{360}\times2\times\pi\times9.6$
6(b)(i)	81	**3**	**M2** for $\frac{A}{36}=\left(\sqrt[3]{\frac{2187}{648}}\right)$ oe or better or for $A\times\frac{648}{36}\times\sqrt[3]{\frac{2187}{648}}=2187$ oe or better or **M1** for $\frac{A^3}{36^3}=\frac{2187^2}{648^2}$ oe or $\sqrt[3]{\frac{2187}{648}}$ or $\sqrt[3]{\frac{648}{2187}}$
6(b)(ii)	8.05 or 8.051 to 8.052…	**3**	**M2** for $\left[r^3=\right]\frac{2187\times3}{4\times\pi}$ oe or **M1** for $\frac{4\pi r^3}{3}=2187$ **SC2** for $\frac{648\times3}{4\times\pi}$ or **SC1** for $\frac{4\pi r^3}{3}=648$

8(a)	356 or 356.2 to 356.3	**4**	**B1** for [Angle LPM] = 74 soi **M2** for $\frac{248\times\sin \textit{their}\ 74}{\sin 42}$ oe or **M1** for implicit statement
8(b)(i)	320 or 319.9 to 320.2...	**3**	**B1** for angle PLM = 64 soi or for angle between LM and perpendicular from M = 26 soi or [PM =] 333.[1…] **M1** for *their* 356 × sin *their* 64 oe or *their* 356 × cos *their* 26 oe
8(b)(ii)	02 57 or 2 57 am	**3**	**B2** for 6 hours 12 mins or 372 mins seen or **M1** for 248 ÷ 40 oe If 0 scored, **SC1** for *their* time in hours converted to hours and minutes

5(a)(i)	1930 or 1940 or 1933.4 to 1935.3	**5**	**B1** for interior angle 120 soi or angle at centre 60 soi or for correct use of Pythagoras' with 7 and 3.5 or with 14 and 7 **M3** for $6\times\frac{1}{2}\times7^2\times\sin 60\times 15.2$ oe or complete other methods or **M2** for $6\times\frac{1}{2}\times7^2\times\sin 60$ oe OR **M1** for $\frac{1}{2}\times7^2\times\sin 60$ oe or other partial area of hexagon **M1dep** for *their* area × 15.2 evaluated
5(a)(ii)	893 or 892.8 to 893.0…	**3**	**M2** for $6\times7\times15.2+2\times 6\times\frac{1}{2}\times7^2\times\sin 60$ oe or for 6 × 7 × 15.2 + 2 × *their* area of hexagon from **(a)** oe or **M1** for [6 ×] 7 × 15.2 oe or 2 × *their* area of hexagon from **(a)** oe
5(b)	2.71 or 2.709 to 2.710	**3**	**M2** for $\sqrt[3]{500\div\left(6\times\frac{4}{3}\pi\right)}$ oe or **M1** for $500=6\times\frac{4}{3}\pi r^3$ oe If 0 scored, **SC1** for answer 4.92 or 4.923 to 4.924

2(a)	128	**2**	**M1** for $4\times\frac{1}{2}\times8\times8$ oe
2(b)(i)	18.3 or 18.26 to 18.29…	**3**	**M2** for $\frac{1}{4}(\pi\times8^2-\textit{their}128)$ oe or **M1** for $\pi\times8^2-\textit{their}128$ oe or for $\frac{1}{4}\times\pi\times8^2$ oe OR **SC2dep** for answer 4.56 to 4.57...
2(b)(ii)	23.9 or 23.87 to 23.882	**4**	**M3** for $\frac{90}{360}\times2\times\pi\times8+\sqrt{8^2+8^2}$ oe OR **M1** for $\frac{90}{360}\times2\times\pi\times8$ oe **M1** for $\sqrt{128}$ oe OR **SC3dep** for answer 11.9 or 11.93 to 11.94…

2(a)(i)	9	**1**	
2(a)(ii)	*ABCD* completed accurately with arcs	**2**	**M1** for intersecting arcs radius *their* 9 cm or for *ABCD* completed accurately with no arcs
2(b)	Correct ruled perpendicular bisector of *AB* with 2 correct pairs of arcs Correct ruled bisector of angle *ABC* with 2 correct pairs of arcs Lines intersecting	**4**	**B2** for correct ruled perpendicular bisector of *AB* with 2 correct pairs of arcs or **B1** for correct perpendicular bisector without/wrong arcs and **B2** for correct ruled bisector of angle *ABC* with 2 correct pairs of arcs or **B1** for correct bisector of angle *ABC* without/wrong arcs If lines do not intersect, max **B3**

6(a)	4.79 or 4.788 to 4.789	**3**	**M2** for $\sqrt[3]{\frac{230\times3}{2\times\pi}}$ oe or **M1** for $230=\frac{2}{3}\times\pi\times r^3$ oe If 0 scored **SC1** for answer 3.8[0…]
6(b)(i)	8.7[0] or 8.702 to 8.704	**3**	**M2** for $(300-230)\div(1.6^2\pi)$ or **M1** for $\pi\times1.6^2\times h$
6(b)(ii)	6.4	**3**	**M2** for $1.6\times\sqrt[3]{\frac{19200}{300}}$ oe or **M1** for sf $\sqrt[3]{\frac{19200}{300}}$ or $\sqrt[3]{\frac{300}{19200}}$ oe or for $\left(\frac{1.6}{r}\right)^3=\frac{300}{19200}$

8(a)	18	**3**	**B2** for 20 nfww or **M1** for $8x + x = 180$ or better
8(b)	32	**3**	**B1** for angle $DBC = 58$ **B1** for angle $BCD = 90$
8(c)(i)	24	**2**	**B1** for angle $PRQ = 24$
8(c)(ii)	29.4 or 29.40 to 29.41	**3**	**M2** for $\frac{360-48}{360}\times 2\times\pi\times 5.4$ or **B2** for answer (minor arc) 4.52 or 4.523 to 4.524… or **M1** for $\frac{48}{360}\times 2\times\pi\times 5.4$

5(a)	$8^2 + 7^2 - 2 \times 7 \times 8 \times \cos 78$ oe	**M2**	**M1** for correct implicit version
	9.471.. to 9.472	**A2**	**A1** for 89.7…
5(b)	46.3 or 46.29 to 46.30…	**3**	**M2** for $[\sin OAC =]\frac{7\sin 78}{9.47}$ or **M1** for $\frac{\sin OAC}{7}=\frac{\sin 78}{9.47}$

5(c)	29.5 – (7 + 8 + 9.47)	**M1**	
	$\frac{360\times(29.5-(7+8+9.47))}{2\times\pi\times 7}$	**M3**	**M2** for $\frac{x}{360}\times 2\times\pi\times 7 =$ *their* arc length oe or **M1** for $\frac{x}{360}\times 2\times\pi\times 7$ oe
	41.15 to 41.171..	**B1**	
5(d)	45[.0] or 44.98 to 45.01 nfww	**4**	**M3** for ½ × 8 × 7 × sin 78 oe + $\frac{41.2}{360}\times\pi\times 7^2$ oe OR **M1** for ½ × 8 × 7 × sin 78 oe or ½ × 8 × 9.47 × sin *their* **(b)** oe **M1** for $\frac{41.2}{360}\times\pi\times 7^2$ oe

7(a)	$x^2 + (2x - 3)^2 = 6^2$ oe or $x^2 + 4x^2 - 6x - 6x + 9 = 36$	**M1**	
	$4x^2 - 6x - 6x + 9$ or better	**B1**	
	$5x^2 - 12x - 27 = 0$	**A1**	Dep on **M1B1** with no errors or omissions
7(b)	$\frac{-(-12) \pm \sqrt{(-12)^2 - 4(5)(-27)}}{2 \times 5}$ or better or $\frac{12}{10} \pm \sqrt{\left(\frac{12}{10}\right)^2 + \frac{27}{5}}$	**B2**	**B1** for $\sqrt{(-12)^2 - 4(5)(-27)}$ or for $\left(x - \frac{12}{10}\right)^2$ oe or $\frac{-(-12) + \sqrt{q}}{2 \times 5}$ oe or $\frac{-(-12) - \sqrt{q}}{2 \times 5}$ oe or both
	– 1.42, 3.82 final answers	**B2**	**B1** for each If **B0**, **SC1** for answers – 1.4 or –1.415… to – 1.415 **and** 3.8 or 3.815 to 3.815… or answers –1.41 and 3.81 or – 1.42 **and** 3.82 seen in working or for –3.82 and 1.42 as final ans
7(c)	14.4 or 14.5 or 14.44 to 14.46	**2**	**2FT** for 3 × *their* positive root + 3 evaluated to 3sf or better **M1** for 3 × *their* positive root + 3 oe
7(d)	39.5 or 39.46 to 39.54…	**2**	**M1** for trig statement seen to find either angle sin = $\frac{\textit{their } x}{6}$ oe or sin = $\frac{\textit{their } (2x - 3)}{6}$ oe

9(a)(i)(a)	62 and Isosceles [triangle] and Angle at centre is twice angle at circumference oe	**3**	**B2** for 62 and one correct reason or **B1** for 62 with no/wrong reason or for angle *EOD* = 124 soi or for no/wrong angle with correct reason
9(a)(i)(b)	62 and [Angles in] same segment oe or angle at centre is twice angle at circumference oe	**2**	**2FT** *their* **(a)(i)(a)** and correct reason **B1FT** for *their* **(a)(i)(a)** with no/wrong reason or for no/wrong angle with correct reason
9(a)(ii)	8	**3**	**M2** for (180 –109) – 28 – 35 oe or **M1** for [angle *AED* =] 180 – 109 oe
9(b)(i)	24	**3**	x = ext angle **B2** for [x =] 15 isw or **M1** for $x + 11x = 180$ oe or for $\frac{180(n-2)}{[n]} = \frac{360}{[n]} \times 11$
9(b)(ii)	3960	**2**	**FT** (*their* 24 – 2) × 180 dep on **(b)(i)** an integer and > 6 **M1** for (*their* 24 – 2) × 180 oe or *their* 24 × 11 × *their* 15 oe or 11 × 360

6(a)(i)	116.6 or 116.56 to 116.57	**4**	**M1** for $\sin[EAD]=\frac{6}{12}$ oe **M1** for $\tan[BAC]=\frac{6}{12}$ oe **B1** for [angle DAC] = 60
6(a)(ii)	13.4 or 13.41 to 13.42	**2**	**M1** for 12^2+6^2
6(a)(iii)	10.4 or 10.39…	**3**	**M2** for $\sqrt{12^2-6^2}$ or **M1** for $AE^2+6^2=12^2$
6(a)(iv)	130 or 129.5… to 129.6	**4**	**M1** for $0.5\times6\times theirAE$ oe **M1** for $0.5\times12\times12\times\sin 60$ oe **M1** for $0.5\times6\times12$ oe
6(b)(i)	3	**1**	
6(b)(ii)	51.3 or 51.30 to 51.34…	**4**	**M3** for $\tan=\frac{8}{\sqrt{4^2+5^2}}$ or $\sin=\frac{8}{\sqrt{4^2+5^2+8^2}}$ oe or **M2** for $\sqrt{4^2+5^2}$ or $\sqrt{4^2+5^2+8^2}$ or **M1** for angle ARB clearly indicated
7(a)	204 or 203.5 to 203.6… nfww	**4**	**M2** for $\pi\times1.5^2\times8\times60\times60$ or **M1** for $\pi\times1.5^2$ **M1** for dividing *their* volume by 1000 If 0 scored **SC1** for an answer figs 204 or figs 2035 to 2036 without working
7(b)(i)	$\pi\times6\times12+\pi\times6^2=108\pi$	**M2**	**M1** for $\pi\times6\times12$
7(b)(ii)	[x =] 5.2[0] or 5.196… [y =] 6	**4**	**B2** or **M1** for $4\pi x^2=108\pi$ seen **B2** or **M1** for $\frac{1}{2}(4\pi y^2)+\pi y^2$ or better seen
1(b)	21	**3**	**M2** for $15\times\sqrt{\frac{352.8}{15\times12}}$ oe or **SC2** for answer 16.8 or **M1** for $\sqrt{\frac{352.8}{15\times12}}$ or $\sqrt{\frac{15\times12}{352.8}}$ seen or **M1** for a correct implicit statement for the length

5(a)(i)	$[h =]\ 253.8 \div 18 \div \left(\frac{6}{2}\right)$ or $[h =]\ \frac{253.8 \times 2}{6 \times 18}$ or $[h =]\ \frac{253.8}{18 \times \frac{6}{2}}$	**3**	For **M3** no errors at any stage **M2** for $253.8 = \frac{1}{2} \times 6 \times h \times 18$ oe (no previous errors) or **M1** for triangle area $= \frac{1}{2} \times 6 \times h$ soi
5(a)(ii)	38.1 or 38.06 to 38.08	**2**	**M1** for $\tan = \frac{4.7}{6}$ oe
5(b)	358 or 357.9 to 358	**6**	**M1** for $6^2 + 4.7^2$ **M1** for $\sqrt{6^2 + 4.7^2} \times 18$ [× 2] **M1** for 6 × 18 [× 2] **M1** for 4.7 × 18 **M1** for $2 \times \frac{1}{2} \times 6 \times 4.7$ oe

7(a)	42.2 or 42.23....	**2**	**M1** for $\frac{1}{2} \times 8.9 \times 12.5 \times \sin 130.6$ oe
7(b)(i)	27[.0] or 27.00 to 27.01	**3**	**M2** for $\frac{11.6 \times \sin 123.5}{21.3}$ or **M1** for $\frac{11.6}{\sin BCD} = \frac{21.3}{\sin 123.5}$ oe
7(b)(ii)	15.9 or 15.90 to 15.91	**5**	**M1** for angle ABD = *their* angle BCD + 33.5 **and** **M2** for $11.6^2 + 18^2 - 2 \times 11.6 \times 18 \times \cos(theirABD)$ or **M1** for implicit version **A1** for 252.9 to 253

10(a)	132.26 to 132.28 or 132.3	**5**	**B1** for angle *ABO* or angle *CBO* = 90 soi **M1** for tan [*XOB*] $= \frac{15}{8}$ oe **M1** for tan [*BOY*] $= \frac{22.4}{8}$ oe **A1** for [*BOY* =]70.3… or [*XOB* =] 61.9….
10(b)	18.4 or 18.5 or 18.43 to 18.48	**2**	**M1** for $\frac{their\ (a)}{360} \times 2 \times \pi \times 8$ oe
10(c)	75.7 to 75.9	**4**	**M1** for $\frac{1}{2}(15 + 22.4) \times 8$ oe **M2** for $\frac{their\ (a)}{360} \times \pi \times 8^2$ oe or **M1** for one sector either $\frac{inv\tan\left(\frac{15}{8}\right)}{360} \times \pi \times 8^2$ oe or $\frac{inv\tan\left(\frac{22.4}{8}\right)}{360} \times \pi \times 8^2$ oe

4(a)	$\frac{1}{2} \times 4(x - 1) \times (2x + 5)[\sin 90] = 30$ oe	**M1**	
	$8x^2 - 8x + 20x - 20$ or better	**B1**	correct expansion of brackets
	Completion to $2x^2 + 3x - 20 = 0$	**A1**	with no errors or omissions seen
4(b)	$(2x - 5)(x + 4)$	**M2**	Allow **M2** for e.g. $2x(x + 4) - 5(x + 4)$ then $2x - 5[= 0]$ and $x + 4[= 0]$ **M1** for $2x(x + 4) - 5(x + 4)$ or $x(2x - 5) + 4(2x - 5)$ or $(2x + a)(x + b)$ [= 0] where $ab = -20$ or $a + 2b = 3$ [a, b integers]
	2.5 and –4 cao	**B1**	

4(c)	11.7 or 11.66 … or 11.67	**3**	**M2dep** for $(4(their 2.5 - 1))^2 + (2 \times their 2.5 + 5)^2$ or **M1dep** for $4(their 2.5 - 1)$ or $2 \times their 2.5 + 5$ OR **B1** for $\sqrt{20x^2 - 12x + 41}$ and **M1dep** for substituting x = *their* 2.5 into $\sqrt{20x^2 - 12x + 41}$ at any stage

7(a)	29	**1**	
7(b)	128	**2**	**FT** 180 – 2 (55 – *their* **(a)**) **M1** for angle *OCA* or angle *OAC* = 55 – *their* **(a)** soi

7(c)	64	**1**	**FT** *their* **(b)** ÷ 2
7(d)	116	**1**	**FT** 180 – *their* **(c)**

8(a)	370 or 370.2 to 370.3	**2**	**M1** for 864 ÷ *their* time
8(b)	991 or 990.5 …	**4**	**M2** for $864^2 + 928^2 - 2 \times 864 \times 928\cos 67$ or **M1** for correct implicit version **A1** for 981100 to 981110
8(c)(i)	313	**2**	**M1** for 180 + 133 or 360 – 47
8(c)(ii)	[0]79.5 to [0]79.6 …	**4**	**M2** for $\frac{928\times\sin 67}{\textit{their}\ 991}$ or $\frac{864\times\sin 67}{\textit{their}\ 991}$ oe or **M1** for implicit form of either **A1** for [angle *HGB* =] 59.5 to 59.6 … or [angle *HBG* =] 53.4 or 53.37 to 53.42 **M1 dep** for *their* angle *HGB* + 20 leading to answer or for 133 – *their* angle *HBG* leading to answer

10(a)(i)	75 000 × 60 × 20 oe	**M1**	Allow × 1200 for × 60 × 20
10(a)(ii)	16.4 or 16.36 …	**3**	**M2** for $\frac{9\times10^7\times100}{1000\times55\times10^4}$ oe or **B2** for answer 0.164 or 0.1636 … or **B1** for answer figs 164 or 1636 … or **M1** for figs 9 ÷ figs 55
10(a)(iii)	28.3 or 28.27 to 28.28	**3**	**M2** for $\frac{76}{360} \times 2\pi \times 8.5 + 2 \times 8.5$ oe or **M1** for $\frac{76}{360} \times 2\pi \times 8.5$ oe

10(b)(i)	3770 or 3769 to 3770. …	**2**	**M1** for $\frac{1}{3}\times\pi\times10^2\times36$
10(b)(ii)	3.68 or 3.683 to 3.684 …	**4**	**M3** for $[r^3=]\ \frac{1}{2}\times$ *their* **(b)(i)** $\times\ \frac{3}{4\pi\times9}$ oe or **M2** for $\frac{4\pi r^3}{3}+\frac{4\pi(2r)^3}{3}=\frac{1}{2}\times$ *their* **(b)(i)** or for $\frac{4\pi r^3}{3}=\frac{1}{1+8}\times\frac{1}{2}\times$ *their* **(b)(i)** or **M1** for $\frac{4\pi r^3}{3}+\frac{4\pi(2r)^3}{3}$ or $\frac{1}{2}\times\frac{\pi\times10^2\times36}{3}$ or $\frac{1}{2}$ *their* **(b)(i)** seen or ratio of vols = $1:2^3$ oe seen

3(a)(i)	427 or 427.2 to 427.3…	**2**	**M1** for $\pi\times8\times17$
3(a)(ii)	1010 or 1005….	**4**	**M2** for $\sqrt{17^2-8^2}$ oe or **M1** for $h^2+8^2=17^2$ oe **M1** for $\frac{1}{3}\times\pi\times8^2\times$*their* h oe
3(a)(iii)	804 or 804.2 to 804.4 or 808	**1**	**FT** *their* **(ii)** × 0.8
3(a)(iv)	396 or 395.6 to 395.8 or 392	**1**	**FT** 1200 – *their* **(iii)**
3(b)(i)	$\frac{1}{54}$	**4**	**B3** for $\frac{\frac{4}{3}\pi r^3}{72\pi r^3}$ or better or **M2** for $\frac{\frac{4}{3}\times\pi\times r^3}{\pi\times(3r)^2\times8r}$ or $72\times\pi\times r^3$ or **M1** for $\pi\times(3r)^2\times8r$ If 0 scored, **SC2** for answer of $\frac{1}{18}$
3(b)(ii)	972π final answer	**4**	**B2** for $r=\frac{9}{2}$ oe or **M1** for $4\pi r^2=81\pi$ or better **M1** for $2\times\pi\times(3\times$*their* $r)\times(8\times$*their* $r)$ isw

6(a)	52[.0] or 52.02…	**4**	**M2** for [cos =] $\frac{13^2+4^2-11^2}{2\times13\times4}$ or **M1** for $11^2 = 13^2+4^2-2\times13\times4\cos(...)$ **A1** for [$\cos^{-1}$ =] $\frac{64}{104}$ oe or 0.615 or 0.6153 to 0.6154
6(b)	62.7 or 62.69 to 62.70	**4**	**M3** for $180 - \sin^{-1}\left(\frac{8\sin80}{13}\right) - 80$ oe or **M2** for $\sin A = \frac{8\sin80}{13}$ or **M1** for $\frac{13}{\sin80} = \frac{8}{\sin A}$ oe **A1** for 37.3 or 37.30… If 0 scored, **M1** for 180 – 80 – *their A*
6(c)	66.7 or 66.68 to 66.71	**3**	**M1** for $0.5\times13\times4\times\sin(theirACB)$ oe **M1** for $0.5\times8\times13\times\sin(their\ ACD)$ oe

8(a)(i)	4	**2**	**M1** for correct method using similar triangles e.g. $\frac{10}{5} = \frac{8}{DX}$ oe
8(a)(ii)	36.9 or 36.86 to 36.87	**2**	**M1** for tan = $\frac{6}{8}$ or sin = $\frac{6}{10}$ or cos = $\frac{8}{10}$ oe
8(b)	[*v* =] 150	**B1**	
	[*w* =] 15	**B2**	**FT** (180 – *their v*) ÷ 2 **M1** for 180 – 2*w* = *their v* oe or angle *POQ* = 180 – *their v* oe
	[*x* =] 15	**B1**	**FT** *their w*
	[*y* =] 10	**B2**	**M1** for angle *TPS* = 5° or angle *TXS* = 20° or *OXP* = 20° or *TXP* = 160° (where *X* is where *OT* and *PS* intersect)
8(c)	182 or 182.4…	**3**	**M2** for $\left(\frac{94}{226}\right)^{\frac{3}{2}}$ $\left[=\frac{V}{680}\right]$ oe or **M1** for ratio of lengths = $\sqrt{\frac{226}{94}}$ or $\sqrt{\frac{94}{226}}$ or better or for $\frac{V^2}{680^2} = \frac{94^3}{226^3}$ oe

6	**(a) (i)**	27	**1**	
	(ii)	3.89 or 3.888 to 3.889	**2**	**M1** for $\frac{7}{EZ}=\frac{9}{5}$ oe
	(b)	76 cao	**3**	**B2** for $ABC = 104$ or $AOC = 152$ or $COD = 28$ or $OBA = 52$ **and** $OBC = 52$ or $BCD = 128$ **and** $OCB = 52$ or **B1** for any one of OBA, OBC, $OCB = 52$ or $BCD = 128$

	(c) (i)	90	**1**	
		angle in semicircle	**1**	
	(ii)	27	**1**	
		tangent [perpendicular to] radius	**1**	
	(iii)	rectangle	**1**	

8	**(a) (i)**	5.14 or 5.135 to 5.142 nfww	**4**	**M2** for $[XY^2 =] 12.5^2 + 9.9^2 - 2 \times 12.5 \times 9.9 \times \cos 23$ or **M1** for implicit version **A1** for 26.4 to 26.5 OR **B1** for $[XYT =] 108$ or $[TXY =] 49$ **M2** for $\frac{12.5\sin 23}{\sin(180-72)}$ oe or **M1** for $\frac{\sin(180-72)}{12.5}=\frac{\sin 23}{XY}$ oe

	(ii)	15.6 or 15.7 or 15.64 to 15.68	**3**	**M2** for $[TZ=]\frac{9.9}{\sin 37}\times\sin(72)$ oe or **M1** for $\frac{9.9}{\sin 37}=\frac{TZ}{\sin 72}$ oe OR **M2** for $\frac{12.5\times\sin(180-23-108)}{\sin 37}$ oe or **M1** for $\frac{\sin 37}{12.5}=\frac{\sin(180-23-108)}{TZ}$ oe
	(b)	3.79 or 3.793 to 3.794	**4**	**M3** for $r = 20.5 \div \left(2+\frac{3\times 65\times 2\pi}{360}\right)$ oe or **M2** for $20.5 = 2r + \frac{3\times 65}{360}\times 2\pi r$ oe or **M1** for $[3\times]\frac{65}{360}\times 2\pi r$ oe or $20.5 = 2r$ + expression involving π

10 (a) (i)	$(6-2)\times 180$ or $(2\times 6-4)\times 90$ or $(360\div 6)$	**M1**	
	$(6-2)\times 180\div 6$ or $(2\times 6-4)\times 90\div 6$ or $180-(360\div 6)$	**M1dep**	dep on previous M1
(ii)	$1.73x$ or $x\sqrt{3}$ oe	**3**	**M2** for $2x\sin 60$ or $2x\cos 30$ oe or for $\sqrt{x^2+x^2-2\times x\times x\times\cos 120}$ or **M1** for $x\sin 60$ or $x\cos 30$ oe or for $x^2+x^2-2\times x\times x\times\cos 120$

(iii)	$(10-x)\sin 30$ seen oe	**M1**	
	$10+2\big((10-x)\sin 30\big)$ oe	**M1dep**	dep on previous **M1**
	$10+10-x$ or $10+2\times\frac{1}{2}\times(10-x)$	**A1**	with no errors or omissions seen
(b)	12.7 or 12.67 to 12.68.... nfww	**4**	**B3** for 7.32 to 7.33 or **M2** for $x=20\div(1+1.73)$ oe or **M1** for $20-x=$ *their* **(a)(ii)** oe

5(a)(i)	50890 or 50893 to 50900.4	**2**	**M1** for $\pi\times 18^2\times 50$

5(a)(ii)	20.5 or 20.52 to 20.534	**3**	**B2** for answer 29.5 or 29.46 to 29.48 OR **M2** for $(50900-30000)\div(\pi\times18^2)$ oe or **M1** for (figs 50.9 –figs 30) ÷ ($\pi\times$ figs18^2) or **M1** for $(50900-30000)=(\pi\times18^2)h$ oe OR **alternative method** **M2** for $50-\frac{30000}{\pi\times18^2}$ oe **M1** for figs $30=\pi\times$figs $18^2\times(50-h)$ oe or for $\frac{\text{figs}30}{\pi\times\text{figs}18^2}$ oe OR **alternative method** **M2** for $\frac{(50.9-30)}{50.9}\times50$ oe or **M1** for $\frac{(50.9-30)}{50.9}$ or $\frac{30}{50.9}\times50$ oe or **M1** for $\frac{(\text{figs }50.9-\text{figs }30)}{\text{figs }50.9}\times50$ oe
5(a)(iii)	334 nfww	**4**	**M2** for figs $30\div\frac{2}{3}\pi\times3.5^3$ oe or **M1** for $\frac{1}{2}\times\frac{4}{3}\pi\times3.5^3$ oe and **B1** for 30 000
5(b)(i)	3.28[6..] or 3.29	**3**	**M2** for [$r^2=$] $\frac{95\times3}{8.4\pi}$ oe or **M1** for $\frac{1}{3}\pi\times r^2\times8.4$ [=95]
5(b)(ii)	93.1 to 93.6	**4**	**M3** for $\pi\times3.3\times\sqrt{3.3^2+8.4^2}$ or **M2** for $\sqrt{3.3^2+8.4^2}$ or **M1** for $3.3^2+8.4^2$

8(a)(i)	290	**2**	**M1** for 180 + 110 oe
8(a)(ii)	156.8 or 156.7[9..]	**5**	**B1FT** for $CBA = 10°$ (*their* **(a)** – 280) and **B3** for [angle ACB =]13.2° or **M2** for [sin C] = $\frac{50\sin(their10)}{38}$ or **M1** for $\frac{50}{\sin C}=\frac{38}{\sin(their10)}$ oe
8(a)(iii)	8.68 or 8.677 to 8.684	**3**	**M2** for [x =]50sin(*their*10) oe or **M1** for $\sin(their10)=\frac{x}{50}$ oe or **M1** for a correct right-angled triangle drawn with 50 as hypotenuse
8(b)(i)	$x(x-25) = 2200$	**1**	and no errors seen
8(b)(ii)	$\frac{-(-25)\pm\sqrt{(-25)^2-4(1)(-2200)}}{2(1)}$ or better	**B2**	**B1** for $\sqrt{(-25)^2-4(1)(-2200)}$ or better **or** for $\left(x-\frac{25}{2}\right)^2$ oe or **B1** for $\frac{-(-25)+\sqrt{q}}{2(1)}$ or $\frac{-(-25)-\sqrt{q}}{2(1)}$ or both or for $\frac{25}{2}+\text{or}-\sqrt{\left(\frac{25}{2}\right)^2+2200}$
	–36.04 and 61.04 final answer	**B1,B1**	If **B0B0, SC1** for values in ranges –36.042 to –36.041 **and** 61.041 to 61.042 seen or for answers –36[.0] or –36.042 to –36.041 **and** 61[.0] or 61.041 to 61.042 or –36.04 **and** 61.04 seen in working or for –61.04 **and** 36.04 as final ans

5(a)(i)	94.2 or 94.3 or 94.24 to 94.26	**2**	**M1** for $\pi \times 3 \times 10$
5(a)(ii)	9.54 or 9.539…	**3**	**M2** for $\sqrt{10^2 - 3^2}$ or **M1** for $h^2 + 3^2 = 10^2$ oe
5(a)(iii)	89.9 or 89.90 to 89.92…	**2**	**M1** for $\frac{1}{3} \times \pi \times 3^2 \times$ *their* **(a)(ii)**
5(b)	108 or 107.9 to 108.1 nfww	**4**	**M3** for $\frac{\pi \times 3 \times 10}{\pi \times 10^2} \times 360$ oe or $\frac{\textit{their}\ \textbf{(a)(i)}}{\pi \times 10^2} \times 360$ oe or $\frac{2 \times \pi \times 3}{2 \times \pi \times 10} \times 360$ oe or **M2** for $\frac{x}{360} \times \pi \times 10^2 = \textit{their}$**(a)(i)** oe or $\frac{x}{360} \times 2 \times \pi \times 10 = 2 \times 3 \times \pi$ oe or **M1** for $\frac{x}{360} \times \pi \times 10^2$ seen or $\frac{x}{360} \times 2 \times \pi \times 10$ seen
5(c)	46.6 to 46.8	**4**	**M3** for $\frac{\textit{their}\ \textbf{(b)}}{360} \times \pi \times 10^2 - \frac{1}{2} \times 10 \times 10 \times \sin(\textit{their}\ \textbf{(b)})$ oe or **M1** for $\frac{\textit{their}\ \textbf{(b)}}{360} \times \pi \times 10^2$ or *their* **(a)(i)** soi and **M1** for $\frac{1}{2} \times 10 \times 10 \times \sin(\textit{their}\ \textbf{(b)})$ soi

7(a)(i)	4.5 or $4\frac{1}{2}$ or $\frac{9}{2}$ final answer	**3**	**M2** for [2](4*x* + 7) = [2](6*x* – 2) oe or **M1** for 2(2*x* + 6) + 2(2*x* + 1) oe or 4(3*x* – 1) oe or **M1** for correctly reaching $ax = b$ from *their* linear equation
7(a)(ii)	$(2x+6)(2x+1) = (3x-1)^2$	**M1**	May be seen in different stages
	$5x^2 - 20x - 5\ [=0]$ oe	**B3**	**B1** for $4x^2 + 2x + 12x + 6$ or better **B1** for $9x^2 - 3x - 3x + 1$ or better
	$\frac{-(-20) \pm \sqrt{(-20)^2 - 4(5)(-5)}}{2(5)}$ oe	**M2**	**FT** their 3 term quadratic provided formula used or complete the square **M1** for $\sqrt{(-20)^2 - 4(5)(-5)}$ oe or if in form $\frac{-(-20) + \sqrt{q}}{2(5)}$ or $\frac{-(-20) - \sqrt{q}}{2(5)}$ **FT**± *their* quadratic or for completing the square **M2** for $2 \pm \sqrt{1 + 2^2}$ or **M1** for $(x - 2)^2$
	4.24 or 4.236… cao	**B1**	

8(a)	66[.0] or 66.03 to 66.04	**2**	**M1** for $\tan = \frac{9}{4}$ oe
8(b)	$\sqrt{3^2+4^2}$ or $\frac{1}{2}\sqrt{6^2+8^2}$	**M1**	Any alternative method must be full and complete and result in exactly 5
8(c)	60.9 or 60.94 to 60.95	**2**	**M1** for $\tan = \frac{9}{5}$ oe
8(d)	5.83 or 5.84 or 5.827 to 5.840	**6**	**M1** for [PB or PC =] $\sqrt{9^2+5^2}$ or [XC =] $\sqrt{9^2+5^2} - 7.5$ **M1** for angle $BPX = 2 \times \text{invsin}\frac{3}{\textit{their } PB}$ oe **B1** for [PB or PC =] $\sqrt{106} = 10.29$ to 10.30 or $XC = 2.79$ to 2.8[0] or angle $BPX = 33.9$ or 33.86 to 33.90… **M2** for $\sqrt{(\textit{their } PB)^2 + 7.5^2 - 2 \times \textit{their } PB \times 7.5 \times \cos(\textit{their } BPX)}$ oe or **M1** for correct implicit equation

2(a)	38	**1**	
	118	**1**	
	62	**1FT**	**FT** 180 – *their y*
2(b)	69	**3**	**B2** for $ACB = 42$ or **B1** for $ADB = 42$ If zero scored, **SC1** for *ACB = their ADB*
2(c)	107	**2**	**B1** for $QPS = 73$ or [reflex] $QOS = 214$

4(a)(i)	17.5 or 17.46....nfww	**6**	**B3** for triangle height 3.46[4...] or $\sqrt{12}$ oe or **M2** for $\sqrt{4^2-2^2}$ or **M1** for $h^2+2^2=4^2$ **and M2** for $2\times 7+\frac{1}{2}\times 2\times$*their h* oe or **M1** for $\frac{1}{2}\times 2\times$*their h*
4(a)(ii)	140 or 139.6 to 139.7...	**1FT**	**FT** *their* **(a)** × 8
4(b)(i)	2.62 or 2.618…	**3**	**M2** for $[r^2=]\ \frac{280}{13\pi}$ oe or **M1** for $280=\pi\times r^2\times 13$
4(b)(ii)	10.2 or 10.20… or $10\frac{10}{49}$	**3**	**M2** for $\frac{280}{14^3}$ [×100] oe or **B1** for 2744 or 14^3 seen

9(a)	1120 or 1121.	**4**	**M2** for $[AC^2=]$ $525^2+872^2-2\times 525\times 872\times\cos 104$ or **M1** for implicit version **A1** for 1257000 to 1258000
9(b)	[*QB* or *x* =] 872 × tan 1 seen	**M2**	**M1** for $\tan 1=\frac{QB}{872}$
	tan = *their QB* ÷ 525	**M1**	
	1.7 or 1.660 to 1.661 nfww	**A1**	dep on **M3**
9(c)(i)	222000 or 222100. .... or 222101	**2**	**M1** for $\frac{1}{2}\times 525\times 872\times\sin 104$
9(c)(ii)	5.55 or 5.550 to 5.553 nfww	**2FT**	**FT** *their* **(c)(i)** × $100^2\div 20000^2$ **M1** for *their* **(c)(i)** × $100^2\div 20000^2$ or restart

2(a)	122	**4**	**B3** for 238 or 61 or 58 correctly identified in working or on diagram or **B2** for 952 seen or 74 or 119 or 29 correctly identified in working or on diagram OR Method 1 using sum of interior angles **M1** for (8 – 2) × 180 or 1080 isw **M1** for *their* 1080 – 4 × 32 **M1** for 360 – *their* 952 ÷ 4 OR Method 2 using isosceles triangles and square **M1** for (180 – 32) ÷ 2 or for 90 **M1** for *their* 74 × 2 + 90 or 90 – *their* 74 **M1** for 360 – *their* 74 × 2 + 90 or 90 + 2(90 – *their* 74) OR Method 3 using four kites joined to centre **M1** for 360 ÷ 4 **M1** for (360 – (*their* 90 + 32)) ÷ 2 **M1** for 2(180 – *their* 119) OR Method 4 using square around outside **M1** for 90 – 32 **M1** for (90 – 32) ÷ 2 **M1** for 180 – 2(*their* 29)
2(b)	105	**3**	**M2** for 360 = 2 × y + (2y – 60) oe or 2(180 – y) = 2y – 60 oe or **B1** identifying in working or on diagram a relevant angle in terms of y

8(a)	$\pi \times \frac{5}{2} \times l + \frac{4}{2} \times \pi \times \left(\frac{5}{2}\right)^2 = \frac{115\pi}{4}$ oe or $\frac{115\pi}{4} - \frac{4}{2} \times \pi \times \left(\frac{5}{2}\right)^2 = \pi \times \frac{5}{2} \times l$ oe	**M2**	**M1** for $\pi \times \frac{5}{2} \times l$ or $\frac{4}{2} \times \pi \times \left(\frac{5}{2}\right)^2$
	$\frac{5\pi l}{2} = \frac{65\pi}{4}$ oe or [l =] $\left(\frac{115\pi}{4} - 2 \times \pi \times 2.5^2\right) \div 2.5\pi$ oe	**B1**	nfww oe both terms must be written in terms of π nfww or correct complete method for l with decimals
	[l =] $\frac{65\pi \times 2}{4 \times 5\pi}$ or $\frac{65\pi}{10\pi}$ oe = 6.5	**A1**	Correct calculation with no errors and **B1** earned
8(b)	6	**3**	**M2** for $\sqrt{6.5^2 - 2.5^2}$ or **M1** for $h^2 + 2.5^2 = 6.5^2$ If zero scored, **SC2dep** for answer 4.15[3]…

8(c)	72[.0…] or 71.99… nfww	**4**	**M3** for $\frac{\pi}{3} \times \left(\frac{5}{2}\right)^2 \times$ *their* 6 $+ \frac{1}{2} \times \frac{4\pi}{3} \times \left(\frac{5}{2}\right)^3$ oe or **M1** for $\frac{\pi}{3} \times \left(\frac{5}{2}\right)^2 \times$ *their* 6 oe and **M1** for $\frac{1}{2} \times \frac{4\pi}{3} \times \left(\frac{5}{2}\right)^3$ oe If zero scored, **SC3dep** for $\frac{\pi}{3} \times (5)^2 \times$ *their* 4.15 $+ \frac{1}{2} \times \frac{4\pi}{3} \times (5)^3$ oe or **SC1dep** for $\frac{\pi}{3} \times (5)^2 \times$ *their* 4.15 oe **SC1dep** for $\frac{1}{2} \times \frac{4\pi}{3} \times (5)^3$ oe
8(d)	53.7 or 53.65 to 53.67	**3**	**M1** for figs (*their* **(c)**) × 19.3 × 38.62 or better **M1** for ÷ 1000 soi

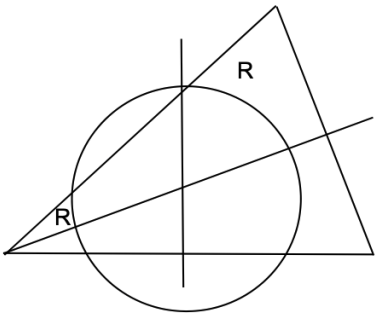
10(a)	$12.5^2 = x^2 + 8.5^2 - 2 \times x \times 8.5\cos 60$ oe isw	**M2**	**M1** for $\cos 60 = \frac{x^2 + 8.5^2 - 12.5^2}{2 \times x \times 8.5}$
	$156.25 = x^2 + 72.25 - 8.5x$	**A1**	or better
	$2x^2 - 17x - 168 = 0$	**A1**	with no errors or omissions
10(b)	$\frac{[--]17 \pm \sqrt{([-]17)^2 - 4(2)(-168)}}{2 \times 2}$	**2**	**B1** for $\sqrt{([-]17)^2 - 4(2)(-168)}$ or better seen and if in form $\frac{p + or - \sqrt{q}}{r}$ **B1** for $p = [- -]\ 17$ **and** $r = 2 \times 2$
	14.35, –5.85 final answers	**1, 1**	**SC1** for 14.352 to 14.353 and –5.853 to –5.852 seen or 14.3 or 14.4 and –5.8 or –5.9 as final answers or –14.35 and 5.85 as final answers or 14.35 and –5.85 seen in working
10(c)	12.2 or 12.17… nfww	**3**	**M2** for $\frac{\textit{their}\ 14.35 \times \sin 46}{\sin 58}$ or **M1** for $\frac{\sin 46}{CD} = \frac{\sin 58}{\textit{their} 14.35}$
10(d)	138 or 137.5 to 137.8 nfww	**3**	**M1** for 0.5 × *their* 14.35 × 8.5sin60 **M1** for 0.5 × *their* 14.35 × *their*12.2 × sin76

2(a)(i)	1070 or 1072. ..	**3**	**M1** for $\pi \times 8^2 \times 2 \times 8$ **M1** for $\frac{4}{3} \times \pi \times 8^3$ or **M2** for $\frac{2}{3}\pi r^3$ or **M1** for $\pi r^2 2r - \frac{4}{3}\pi r^3$
2(a)(ii)	2.58 or 2.580 to 2.581	**3**	**B2** for $r^3 = \frac{36 \times 3}{2\pi}$ or better or **M1** for $\pi \times r^2 \times 2 \times r - \frac{4}{3} \times \pi \times r^3 = 36$ oe
2(b)(i)	4.24 or 4.241 to 4.242	**4**	**M3** for $(\pi \times 5^2 + \pi \times 5 \times \sqrt{5^2 + 12^2})$ or **M2** for $\pi \times 5 \times \sqrt{5^2 + 12^2}$ or **M1** for $5^2 + 12^2$ or $\pi \times 5^2$
2(b)(ii)	64 cao final answer	**3**	**M2** for $\frac{[k\pi] \times 5^2 \times 12}{[k\pi] \times 1.25^2 \times 3}$ or **M1** for $\frac{1}{3} \times \pi \times 5^2 \times 12$ or $\frac{1}{3} \times \pi \times 1.25^2 \times 3$ OR **M2** for 4^3 or $\left(\frac{1}{4}\right)^3$ seen or **M1** for factor 4 or $\frac{1}{4}$ soi
3(a)	7040 or 7035. …	**3**	**M1** for $\frac{1}{2} \times 100 \times 70$ oe **M1** for $\frac{1}{2} \times 100 \times 110 \times \sin 40$ oe
3(b)	374 or 375 or 374.4 to 374.5….	**5**	**M2** for $110^2 + 100^2 - 2 \times 110 \times 100 \times \cos 40$ oe or **M1** for implicit form **A1** for 5250 or 5247. … (or 72.4 or 72.43 to 72.44) **M1** for $70^2 + 100^2$
3(c)	64.3 or 64.27 to 64.28 nfww	**2**	**M1** for $\sin 40 = \frac{\text{distance}}{100}$ oe
3(d)	235	**3**	**B2** for [angle ACB =] 34.99 to 35 or [angle ABC =] 55[.0…] or **M1** for $\tan[ACB] = \frac{70}{100}$ or $\tan[ABC] = \frac{100}{70}$ or equivalent trig ratio

10(a)	5.68 or 5.684 to 5.685	**5**	**M2** for $2x\sqrt{x^2+x^2}$ oe or $2\times\sqrt{2}\times x^2$ or **M1** for $x\sqrt{2}$ or $\sqrt{x^2+x^2}$ oe soi **M1** for $\frac{270}{360}\times\pi\times x^2$ oe **M1** for $0.5\ x^2$ oe
10(b)	4.4[0] or 4.398 to 4.401	**2**	**dep** on a correct value for k in **(a)** **M1** for $\left[x^2\right]=\frac{110}{\textit{their } k}$

1(a)(i)	180 ÷ (2 + 3 + 5) × 5 [= 90]	**1**	with no errors seen
1(a)(ii)	7.05 or 7.053….	**3**	**M2** for $\frac{x}{12}=\sin 36$ oe or better or **B1** for 36 or 54 seen
1(b)(i)	13	**2**	**M1** for 7.8 ÷ 3 soi
1(b)(ii)	36.9 or 36.86 to 36.87	**3**	**B1** for smallest angle identified **M1** for sin[ ] = $\frac{3}{5}$ oe or sin[ ] = $\frac{7.8}{\textit{their}\ \textbf{(b)(i)}}$ oe If zero scored, **SC1** for calculation of 53.1

6(a)(i)	25.5 or 25.46…	**2**	**M1** for $\pi\times 5^2\times h = 2000$ oe
6(a)(ii)	9.85 or 9.847…	**3**	**M2** for $[r^3=]\ 2000\div\left(\frac{2}{3}\pi\right)$ oe or **M1** for $\frac{2}{3}\pi r^3 = 2000$ oe
6(a)(iii)	952 or 952.4….	**3**	**M2** for [6 ×] $\sqrt[3]{2000}^2$ or **M1** for $\sqrt[3]{2000}$ or 6 times *their* area of one face
6(b)(i)	22.5 or 22.49…	**2**	**M1** for $\frac{1}{2}\times 7\times 10\times\sin 40$
6(b)(ii)	$\sqrt{(10^2+7^2-2\times 10\times 7\cos 40)}+7+10$	**M3**	**M2** for $10^2+7^2-2\times 10\times 7\cos 40$ or **M1** for correct implicit cosine rule
	23.46…	**A2**	**A1** for 6.46… or 41.7 to 41.8
6(c)	64.9 or 64.92 to 64.94	**3**	**M2** for $28.2-2\times 9=\frac{c}{360}\times 2\times\pi\times 9$ oe or **M1** for $\frac{c}{360}\times 2\times\pi\times 9$ soi

2	**(a)**	Correct perpendicular bisector of *AB* with 2 pairs of correct arcs isw	**2**	**B1** for accurate with no/wrong arcs or **M1** for correct intersecting arcs with no or wrong line
	(b)	Correct angle bisector at *A* with two pairs of correct arcs isw	**2**	**B1** for accurate with no/wrong arcs or **M1** for two pairs of correct arcs with no or wrong line
	(c)	Circle centre *E* radius 5 cm isw	**2FT**	**FT** circle centre *their E* radius 5 cm provided (a) and (b) attempted **M1** for 250 ÷ 50 oe soi e.g. from arc If 0 scored **SC1** for circle centre *their E*
	(d)		**2**	cao **B1** for each If **0** scored, **SC1** for two 'correct' regions but in part **(c)**, centre correct but radius incorrect

10	**(a)**	5.2[0] or 5.196...	**3**	**M2** for $[h^2=]\ 6^2 - 3^2$ or better or **M1** for $h^2 + 3^2 = 6^2$ or **B1** for *PR* (or *PQ* or *QR*) = 6
	(b) (i)	7.2[0] or 7.196...	**1FT**	**FT** *their* **(a)** + 2
	(ii)	62.4 or 62.35...	**5**	**M4** for 12 × 6 × ½ tan 60 oe or **M3** for 6 × ½ tan 60 oe or **M2** for realising that ½ base = 1 × tan60 oe or **B1** for angle 30 or 60 in correct position on diagram or in a calculation If **0** scored, **SC1** for volume = an area × 12 seen

4	**(a)**	14 137 to 14 137.2 or 14 139	**2**	**M1** for $\frac{4}{3} \times \pi \times 15^3$
	(b) (i)	104 000 or 103 600 to 103 700	**3**	**M2** for $\pi \times 25^2 \times 60 - 14140$ or **M1** for $\pi \times 25^2 \times 60$

(ii)	52.8 or 52.75 to 52.81…	**2**	**M1** for *their* (b)(i) ÷ ($\pi \times 25^2$) or $14\,140 \div (\pi \times 25^2)$
(c) (i)	15.8 or 15.81…..	**3**	**M2** for $[r^2 =] \dfrac{14140}{\frac{1}{3} \times \pi \times 54}$ or **M1** for $\dfrac{1}{3} \times \pi \times r^2 \times 54 = 14\,140$ oe
(ii)	3580 or 3576 to 3581 nfww	**4**	**M1** for $(\textit{their}\ (c)(i))^2 + 54^2$ **M1** for $\pi \times (\textit{their}\ (c)(i)) \times \sqrt{\{(\textit{their}\ (c)(i))^2 + 54^2\}}$ **M1** for $\pi \times (\textit{their}\ (c)(i))^2$

6	**(a)**	3	**1**	
	(b) (i)	9900	**3**	**M2** for $2(60 \times 35) + 2(60 \times 30) + 2(30 \times 35)$ oe or **M1** for one correct rectangle
	(ii)	0.99 oe	**1FT**	FT *their*(b)(i) ÷ 10 000

	(c) (i)	75.7 or 75.66 to 75.67	**4**	**M3** for $\sqrt{60^2+30^2+35^2}$ oe could be in stages or **M2** for $60^2+30^2+35^2$ oe or **M1** for 60^2+30^2 or 60^2+35^2 or 35^2+30^2 oe
	(ii)	23.4 or 23.3 or 23.34 to 23.36…	**3**	**M2** for $\sin^{-1}(30 \div \sqrt{60^2+35^2+30^2})$ oe or for $\sin^{-1}(30 \div$ *their* (c)(i)$)$ or **M1** for $\sin = 30 \div \sqrt{60^2+35^2+30^2}$ oe or for $\sin = 30 \div$ *their* (c)(i)
	(d) (i)	$30 \times 35 \times 60$ [= 63 000]	**1**	With no errors seen
	(ii)	22.4 or 22.38 to 22.391	**3**	**M2** for $\sqrt{\frac{63\,000}{40\pi}}$ oe or **M1** for $40\pi r^2 = 63\,000$ oe
7	**(a)**	360 – 210 [= 150] (180 – 150) ÷ 2 [= 15] **or** 150 ÷ 2 [=75] and 180 – 75 – 90 [=15]	**M1** **M1**	
	(b)	15.5 or 15.45 to 15.46 nfww	**4**	**M3** for $2 \times 8 \cos 15$ oe or **M2** for $8 \cos 15$ oe or **M1** for $\frac{x}{8} = \cos 15$ oe
	(c)	29.5 or 29.4 or 29.39 to 29.50..	**3**	**M2** for [sin ABC =] $\frac{8 \times \sin 72}{their(b)}$ or **M1** for $\frac{\sin ABC}{8} = \frac{\sin 72}{their(b)}$ oe
	(d)	194 or 193.7 to 194.1 nfww	**6**	**M2** for $\frac{210}{360} \times \pi \times 8^2$ or **M1** for $[k]\pi \times 8^2$ seen **and** **M1** for ½ × 8^2 × sin 150 oe **and M2** for ½ × 8 × *their* (b) × sin(108 – *their* (c)) oe or **B1** for [angle CAB=] 108 – *their* (c)
	(e)	12.1 or 12.11 to 12.13	**2FT**	**FT** *their* (d) ÷ 4^2 oe **M1** for 4^2 or $\left(\frac{1}{4}\right)^2$ soi

5	**(a) (i)**	275	**2**	**M1** for $360 - 40 - 45$ oe
	(ii)	095	**2FT**	**FT** *their* (a) – 180 **M1** for *their* (a) – 180 oe or 180 – 40 – 45
	(b)	464.66 to 464.67 [= 464.7]	**4**	**M2** for $510^2 + 720^2 - 2\times510\times720\cos 40$ or **M1** for correct implicit equation **A1** for 215 900 to 215 920
	(c)	44.9 or 44.86 to 44.87…	**3**	**M2** for $\frac{510\sin(40)}{464.7}$ or **M1** for correct implicit equation

9	**(a)**	270 or 270.17 to 270.22	**3**	**M2** for $\frac{360-145}{360}\times\pi 12^2$ oe or **B1** for 215 seen or **M1** for $\frac{\theta}{360}\times\pi 12^2$ used
	(b)	518 or 517.6 to 517.8 nfww	**6**	**B4** for vertical height = 9.62 to 9.63 or **B3** for radius = 7.166 to 7.17 or **B2** for length of sector = 45.[0] or 45.02 to 45.04 or **M1** for $\frac{360-145}{360}\times 2\times\pi\times 12$ oe or for $\sqrt{12^2 - \textit{their radius}^2}$ and **M1** indep for $\frac{1}{3}\pi\times \textit{their radius}^2\times \textit{their h}$ ($h \neq 12$ or $r \neq 12$)

3	**(a) (i)**	51.7 or 51.69 to 51.70…	**4**	**M3** for $(2\times\frac{2}{3}\times\pi\times13^3 + \pi\times13^2\times25)\times2.3$ [÷1000] oe or **SC3** for figs 517 or figs 5169 to 5170… or **M2** for $(2\times\frac{2}{3}\times\pi\times13^3 + \pi\times13^2\times25)$ oe **OR** **M1** for $2\times\frac{2}{3}\times\pi\times13^3$ seen or $\pi\times13^2\times25$ seen **M1indep** for *their* volume × 2.3 ÷ 1000
	(ii)	1.96 or 1.957 to 1.958 …	**4**	**M3** for $(2\times2\times\pi\times13^2 + \pi\times2\times13\times25)[\div100^2]\times4.7$ oe or **SC3** for figs 196 or figs 1957 to 1958… **M2** for $(2\times2\times\pi\times13^2 + \pi\times2\times13\times25)$ oe **OR** **M1** for $2\times2\times\pi\times13^2$ seen or $\pi\times2\times13\times25$ seen **M1indep** for *their* area divided by 100^2 soi

	(b)	6.2[0] or 6.203 to 6.204	**3**	**M2** for $x^3 = \frac{500}{\frac{2}{3}\pi}$ oe or better or **M1** for $\frac{1}{3} \times \pi \times x^2 \times 2x = 500$ oe
	(c)	286 or 285.7…	**3**	**M2** for $\frac{180}{A} = \left(\frac{180}{360}\right)^{\frac{2}{3}}$ oe or **M1** for $\left(\sqrt[3]{\frac{360}{180}}\right)^{[2]}$ oe or $\left(\sqrt[3]{\frac{180}{360}}\right)^{[2]}$ oe seen or $\frac{A^3}{180^3} = \frac{360^2}{180^2}$
6	**(a)**	126 or 126.4 to 126.5	**3**	**M2** for $\sqrt{220^2 - 180^2}$ oe or **M1** for $BC^2 + 180^2 = 220^2$ oe
	(b)	99.9 or 99.86 to 99.87	**4**	**M2** for $180^2 + 170^2 - 2 \times 180 \times 170 \cos 33$ or **M1** for $\cos 33 = \frac{180^2 + 170^2 - CD^2}{2 \times 180 \times 170}$ **A1** for 9970 or 9973 to 9974
	(c)	92.6 or 92.58 to 92.59	**2**	**M1** for $\frac{\text{dist}}{170} = \sin 33$ oe
	(d)	115.1 or 115.0 to 115.1	**3**	**M1** for $\cos = \frac{180}{220}$ oe **M1dep** for 47 + 33 + *their* angle *BAC*
	(e)	19700 or 19708 to 19720	**3**	**M1** for 0.5 × 180 × 170 × sin33 oe or 0.5 × 180 × *their* **(c)** oe **M1** for 0.5 × 180 × *their* **(a)** oe or 0.5 × 180 × 220 × sin(*their BAC*) oe

10	**(a)**	115 or 114.5 to 114.6	**3**	**M2** for $\frac{r^2}{\frac{\pi r^2}{360}}$ or better or **M1** for $\frac{w}{360}\times\pi\times r^2 = r^2$
	(b)	126	**3**	**M2** for $\frac{x}{360}\times 2\pi r[+2r] = [2r+]\frac{7\pi r}{10}$ or better or **M1** for $\frac{x}{360}\times 2\pi r$
	(c)	120	**4**	**B3** for $\frac{y}{2} = 60$ or x (base angle) = 30 OR **M3** for cos x or sin $\left(\frac{y}{2}\right) = \frac{\sqrt{3}}{2}$ oe or cos $y = -\frac{1}{2}$ oe or **M2** for cos x or sin $\left(\frac{y}{2}\right) = \frac{q\sqrt{3}}{2q}$ or $[\cos y] = \frac{q^2+q^2-\left(q\sqrt{3}\right)^2}{2\times q\times q}$ oe or **M1** for $\left[\left(q\sqrt{3}\right)^2 =\right] q^2+q^2-2\times q\times q\cos y$ oe After **M0**, **SC1** for $[h^2 =]q^2-\left(\frac{1}{2}q\sqrt{3}\right)^2$ or for q replaced by 1, 2, 4, etc.

3	**(a)**	$\frac{240\sin 85}{\sin 50}$	**M2**	or **M1** for $\frac{\sin 50}{240}=\frac{\sin 85}{AB}$ oe
		312 or 312.1 ….	**B1**	
	(b)	$\frac{1}{2}\times 180\times 240\times \sin A=12000$	**M1**	
		33.748 to 33.749	**A2**	**A1** for $\sin=\frac{24000}{43200}$ or better or 0.555 or 0.556 or $0.5\dot{5}$ or 0.5555 to 0.5556
	(c)	328 or 328.3 to 328.5	**5**	**B1** for [angle A =] 78.75 seen **M2** for $180^2+(their\ AB)^2-2\times 180\times their\ AB\times\cos 78.75$ or **M1** for $\cos 78.75=\frac{180^2+(their AB)^2-x^2}{2\times 180\times(their AB)}$ **A1** for 107 800 to 107 900
	(d) (i)	108.75 or 108.7 or 108.8	**1**	
	(ii)	288.75 or 288.7 or 288.8	**2FT**	**FT** 180 + *their* **(d)(i)** **M1** for 180 + *their* **(d)(i)** or 360 – (180 – *their***(d)(i)**)

6	**(a) (i)**	1.32	**2**	**M1** for 0.8 × 1.5 × 1.1
	(ii)	0.725 or 0.7246 to 0.7247…	**2**	**M1** for $\pi r^2\times 0.8=their$**(a)(i)** or $\pi r^2=1.5\times 1.1$ oe
	(iii)	0.513 to 0.518 nfww	**5**	**M1** for $2(1.5\times 1.1+1.5\times 0.8+1.1\times 0.8)$ **M1** for [2 ×] $\pi\times(their$ **(a)(ii)**$)^2$ **M2** for $\pi\times 2\times(their$ **(a)(ii)**$)\times 0.8$ or **M1** for $\pi\times 2\times(their$ **(a)(ii)**$)$
	(b) (i)	$x+y\geqslant 9$ oe $y\geqslant 2$ oe	**1** **1**	If zero scored, **SC1** for $x+y>9$ **and** $y>2$
	(ii)	Fully correct diagram with **unwanted** region shaded	**4**	**B1** for $2x+3y=24$ ruled **B1** for $x+y=9$ ruled **B1** for $y=2$ ruled
	(iii)	20 [x =] 7 [y =] 2	**1** **1** **1**	If zero scored, **SC1** for $2x+3y$ evaluated from integers

8	**(a)**	$[u=]$ 80 $[v=]$ 160	**1** **1**	
	(b)	6.24 or 6.244 to 6.245	**3**	**M2** for $\sqrt{8^2-5^2}$ oe or **M1** for $l^2+5^2=8^2$ oe or **B1** for suitable right angled triangle drawn with 5 on correct side
	(c)	5.05 or 5.052….	**2**	**M1** for $\frac{4.8}{2.5}=\frac{9.7}{MN}$ oe
	(d)	4 nfww	**4**	**M3** for $[x^n](x+1)=4\times\frac{5}{12}[x^n](x-1)$ oe, $n=1, 2$ or 3 or **M2** for $\frac{[x](x+1)}{\frac{5}{12}[x](x-1)}=\left(\frac{2[x]}{[x]}\right)^2$ oe or **M1** for 2^2 or $\left(\frac{1}{2}\right)^2$ soi

10	**(a)**	7.5	**2**	**M1** for $3x+x+3x+x=60$ oe
	(b)	5	**3**	**B2** for $3x+4x+5x$ [= 60] or better or **M1** for $(3x)^2+(4x)^2$ oe
	(c)	16.8 or 16.80….	**3**	**M2** for $x+x+\frac{90}{360}\times\pi\times2\times x$ [= 60] oe or **M1** for $\frac{90}{360}\times\pi\times2\times x$ oe

(c)	63	**3**	**M2** for $35\times\sqrt{\frac{2835}{875}}$ oe or **M1** for $\sqrt{\frac{2835}{875}}$ or $\sqrt{\frac{875}{2835}}$ or better or $\frac{\sqrt{2835}}{?}=\frac{\sqrt{875}}{35}$ oe OR **M2** for $\sqrt{2835\times\frac{35}{their(875\div35)}}$ oe or **M1** for $\frac{35}{their(875\div35)}$ or $\frac{their(875\div35)}{35}$

6	**(a)**	$[\cos ABL =] \dfrac{40^2 + 61.1^2 - 92.1^2}{2 \times 40 \times 61.1}$	**M2**	**M1** for correct implicit version
		130.11…	**A2**	**A1** for $[\cos ABL =]$ –0.644… or $-\dfrac{7873}{12220}$ or $-\dfrac{3149.2}{4888}$
	(b)	[0]59.5 or 59.50 to 59.511	**4**	**M2** for $\dfrac{40\sin 130.1}{92.1}$ or $\dfrac{61.1\sin 130.1}{92.1}$ or **M1** for $\dfrac{\sin A}{40} = \dfrac{\sin 130.1}{92.1}$ or $\dfrac{\sin L}{61.1} = \dfrac{\sin 130.1}{92.1}$ **and** **A1** for 19.39 to 19.4… or 30.48 to 30.49…
	(c)	1h 50min	**5**	**M2** for $[BC =] 2 \times 40 \times \cos(180 - 130.1)$ oe or **M1** for $\dfrac{x}{40} = \cos(180 - 130.1)$ oe OR **M2** for $[BC =] \sqrt{\{40^2 + 40^2 - 2 \times 40 \times 40\cos(\textit{their } 80.2)\}}$ or **M1** for correct implicit version OR **M2** for $[BC =] \dfrac{40\sin(\textit{their } 80.2)}{\sin 49.9}$ or **M1** for correct implicit version **and** **M1** for $\dfrac{\textit{their } BC}{28}$ **A1** for 1.84[0…] to 1.841

8	**(a)**	Attempt to use $18 - r$ in Pythagoras'	**M1**	
		$144 = r^2 - 324 + 18r + 18r - r^2$ oe	**B2**	or **B1** for $324 - 18r - 18r + r^2$
		$468 = 36r$ oe	**A1**	Correct simplification with no errors
	(b)	$[2 \times]\ \sin^{-1}\left(\frac{12}{13}\right)$ oe	**M1**	or $\cos = \left(\frac{13^2 + 13^2 - 24^2}{2 \times 13 \times 13}\right)$ or better or $[180 -]\ 2 \times \sin^{-1}\left(\frac{5}{13}\right)$
		134.76…	**A1**	Not 67.4×2

	(c) (i)	332 or 332.1 to 332.2…	**3**	**M2** for $\frac{(360 - 134.8)}{360} \times \pi \times 13^2$ or **M1** for $\frac{134.8}{360} \times \pi \times 13^2$
	(ii)	392 or 392.0 to 392.2…	**3**	**M2** for ½ × 24 × 5 + *their* **(c)(i)** or ½ × 13^2 × sin134.8 + *their* **(c)(i)** or **M1** for ½ × 24 × 5 or ½ × 13^2 × sin134.8
	(iii)	15700 or 15670 to 15690	**1FT**	**FT** for answer to 40 × *their* **(c)(ii)**
	(d)	29.5 or 29.6 or 29.51 to 29.57…	**2FT**	**M1** for $\pi \times 13^2 \times h$ = *their* **(c)(iii)** or better