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EDEXCEL INTERNATIONAL GCSE MATHS: QUESTIONS BY TOPIC

Pythagoras & Trigonometry (G5)

International GCSE Mathematics A (4MA1) · Higher tier

90 questions · 390 marks · Mark schemes included

Past papers June 2018 - June 2025 · 4 sub-topics

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HOW TO USE THIS BOOKLET

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

	QUESTION	SOURCE	MARKS	PAGE
G5a	**PYTHAGORAS' THEOREM**		20 Qs · 84 marks	**4**
1.	**Q8**	IGCSE Paper 2HR June 2018	3	**5**
2.	**Q9**	IGCSE Paper 1H January 2020	3	**6**
3.	**Q4**	IGCSE Paper 2HR January 2020	3	**7**
4.	**Q2**	IGCSE Paper 1H November 2021	3	**8**
5.	**Q20**	IGCSE Paper 1HR June 2025	3	**9**
6.	**Q8**	IGCSE Paper 1H January 2019	4	**10**
7.	**Q3**	IGCSE Paper 1HR January 2019	4	**11**
8.	**Q7**	IGCSE Paper 1HR June 2019	4	**12**
9.	**Q8**	IGCSE Paper 2H November 2020	4	**13**
10.	**Q7**	IGCSE Paper 2HR November 2020	4	**14**
11.	**Q9**	IGCSE Paper 1H January 2022	4	**15**
12.	**Q3**	IGCSE Paper 1HR January 2022	4	**16**
13.	**Q5**	IGCSE Paper 1H June 2023	4	**17**
14.	**Q11**	IGCSE Paper 1H June 2024	4	**18**
15.	**Q10**	IGCSE Paper 2H January 2023	5	**19**
16.	**Q10**	IGCSE Paper 2H June 2025	5	**20**
17.	**Q11**	IGCSE Paper 2HR June 2025	5	**21**
18.	**Q11**	IGCSE Paper 1H November 2020	6	**22**
19.	**Q11**	IGCSE Paper 1HR June 2022	6	**23**
20.	**Q8**	IGCSE Paper 1HR June 2024	6	**25**
G5b	**RIGHT-ANGLED TRIGONOMETRY & EXACT VALUES**		26 Qs · 100 marks	**26**
21.	**Q8**	IGCSE Paper 2H June 2018	3	**27**
22.	**Q7**	IGCSE Paper 2H November 2020	3	**28**
23.	**Q13**	IGCSE Paper 2HR January 2021	3	**29**
24.	**Q7**	IGCSE Paper 2H June 2021	3	**30**
25.	**Q3**	IGCSE Paper 1H January 2022	3	**31**
26.	**Q14**	IGCSE Paper 2H January 2022	3	**32**
27.	**Q12**	IGCSE Paper 2HR January 2022	3	**33**
28.	**Q6**	IGCSE Paper 2H June 2022	3	**34**
29.	**Q5**	IGCSE Paper 2H June 2024	3	**35**
30.	**Q3**	IGCSE Paper 2H November 2024	3	**36**
31.	**Q9**	IGCSE Paper 1HR June 2025	3	**37**
32.	**Q10**	IGCSE Paper 2HR June 2018	4	**38**
33.	**Q7**	IGCSE Paper 2HR January 2019	4	**39**

	QUESTION	SOURCE	MARKS	PAGE
34.	**Q12**	IGCSE Paper 2H June 2019	4	**40**
35.	**Q15**	IGCSE Paper 1HR January 2020	4	**41**
36.	**Q10**	IGCSE Paper 1H January 2021	4	**42**
37.	**Q10**	IGCSE Paper 2H November 2021	4	**43**
38.	**Q10**	IGCSE Paper 1HR January 2023	4	**44**
39.	**Q12**	IGCSE Paper 2H June 2023	4	**45**
40.	**Q12**	IGCSE Paper 1H November 2024	4	**46**
41.	**Q9**	IGCSE Paper 1H June 2018	5	**47**
42.	**Q10**	IGCSE Paper 1H January 2019	5	**48**
43.	**Q13**	IGCSE Paper 2HR November 2020	5	**49**
44.	**Q10**	IGCSE Paper 2HR June 2022	5	**50**
45.	**Q8**	IGCSE Paper 1H January 2023	5	**51**
46.	**Q12**	IGCSE Paper 1H November 2021	6	**53**
G5c	**SINE RULE, COSINE RULE & AREA OF A TRIANGLE**		25 Qs · 121 marks	**54**
47.	**Q18**	IGCSE Paper 2H June 2018	3	**55**
48.	**Q18**	IGCSE Paper 1H June 2019	3	**56**
49.	**Q15**	IGCSE Paper 2HR June 2022	3	**57**
50.	**Q15**	IGCSE Paper 1HR June 2024	3	**58**
51.	**Q15**	IGCSE Paper 2HR June 2024	3	**59**
52.	**Q17**	IGCSE Paper 1H January 2019	5	**60**
53.	**Q21**	IGCSE Paper 1HR January 2019	5	**61**
54.	**Q19**	IGCSE Paper 2HR January 2019	5	**62**
55.	**Q12**	IGCSE Paper 2HR June 2019	5	**63**
56.	**Q14**	IGCSE Paper 1H January 2020	5	**64**
57.	**Q18**	IGCSE Paper 2H November 2021	5	**65**
58.	**Q16**	IGCSE Paper 2HR January 2022	5	**66**
59.	**Q18**	IGCSE Paper 1H June 2022	5	**67**
60.	**Q17**	IGCSE Paper 1HR June 2022	5	**68**
61.	**Q16**	IGCSE Paper 1H January 2023	5	**69**
62.	**Q17**	IGCSE Paper 1HR January 2023	5	**71**
63.	**Q10**	IGCSE Paper 1H November 2023	5	**72**
64.	**Q19**	IGCSE Paper 1H June 2024	5	**73**
65.	**Q20**	IGCSE Paper 1H June 2025	5	**74**
66.	**Q18**	IGCSE Paper 1HR June 2018	6	**75**
67.	**Q19**	IGCSE Paper 2H June 2019	6	**76**
68.	**Q21**	IGCSE Paper 1HR January 2020	6	**78**
69.	**Q18**	IGCSE Paper 2H June 2021	6	**79**
70.	**Q23**	IGCSE Paper 2H January 2022	6	**81**
71.	**Q25**	IGCSE Paper 1HR June 2023	6	**82**
G5d	**3D PYTHAGORAS & TRIGONOMETRY**		19 Qs · 85 marks	**84**
72.	**Q19**	IGCSE Paper 2H June 2018	3	**85**

	QUESTION	SOURCE	MARKS	PAGE
73.	**Q21**	IGCSE Paper 2H June 2019	3	**86**
74.	**Q19**	IGCSE Paper 2HR January 2022	3	**87**
75.	**Q23**	IGCSE Paper 2HR June 2025	3	**88**
76.	**Q20**	IGCSE Paper 1HR January 2019	4	**89**
77.	**Q19**	IGCSE Paper 1H January 2020	4	**90**
78.	**Q22**	IGCSE Paper 2HR January 2021	4	**91**
79.	**Q22**	IGCSE Paper 1H June 2021	4	**93**
80.	**Q18**	IGCSE Paper 1HR June 2022	4	**94**
81.	**Q21**	IGCSE Paper 1HR January 2023	4	**95**
82.	**Q24**	IGCSE Paper 2H June 2025	4	**96**
83.	**Q18**	IGCSE Paper 2H November 2020	5	**98**
84.	**Q21**	IGCSE Paper 1H January 2022	5	**99**
85.	**Q22**	IGCSE Paper 2H June 2023	5	**101**
86.	**Q22**	IGCSE Paper 2HR June 2023	5	**103**
87.	**Q23**	IGCSE Paper 2HR June 2019	6	**105**
88.	**Q17**	IGCSE Paper 1HR November 2020	6	**107**
89.	**Q22**	IGCSE Paper 1HR June 2024	6	**108**
90.	**Q17**	IGCSE Paper 2H January 2021	7	**110**

QUESTIONS

90 questions · 390 marks · 4 sub-topics

SUB-TOPIC G5a

PYTHAGORAS' THEOREM

Sub-topic G5a · 20 questions · 84 marks · lowest tariff first

7 (a) Simplify fully $\frac{20x^2y^6}{4x^2y^2}$

.....

(2)

(b) Make e the subject of the formula $h = 3e + f$

.....

(2)

(Total for Question 7 is 4 marks)

8 From point A, Stanley walks 200 m due east to point B.
From B, he then walks 160 m due south to point C.

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

..... metres

(Total for Question 8 is 3 marks)

9 Here is a right-angled triangle.

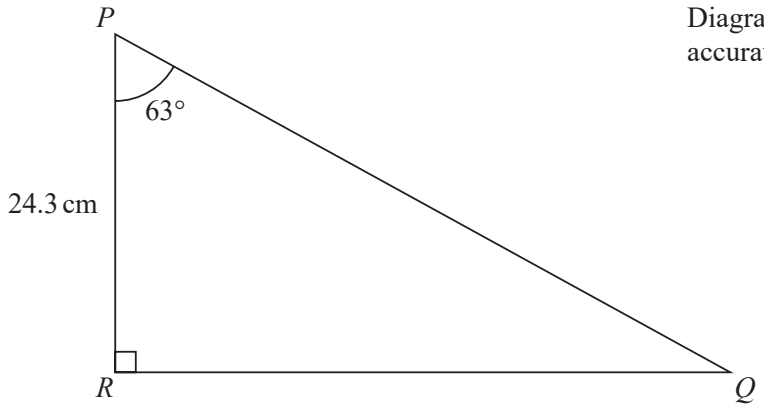


Diagram **NOT** accurately drawn

Calculate the length of PQ.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 9 is 3 marks)

4 The diagram shows a rectangle and a diagonal of the rectangle.

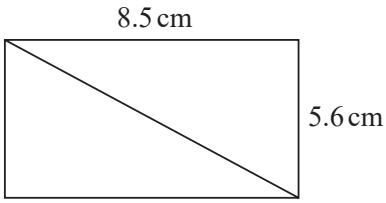


Diagram **NOT** accurately drawn

Work out the length of the diagonal of the rectangle.
Give your answer correct to 1 decimal place.

..... cm

(Total for Question 4 is 3 marks)

5 A plane takes 3 hours 36 minutes to fly from the Cayman Islands to New York.
The plane flies a distance of 2470 km.

Work out the average speed of the plane in km/h.
Give your answer correct to the nearest whole number.

..... km/h

(Total for Question 5 is 3 marks)

Answer ALL TWENTY questions.

Write your answers in the spaces provided.

You must write down all the stages in your working.

1 (a) Simplify $e^8 \div e^2$

.....

(1)

(b) Expand and simplify $(x - 3)(x + 1)$

.....

(2)

(Total for Question 1 is 3 marks)

2 Here is a right-angled triangle.

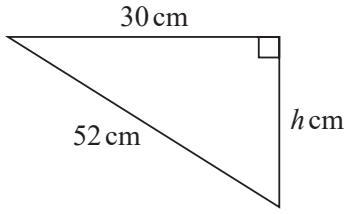


Diagram **NOT** accurately drawn

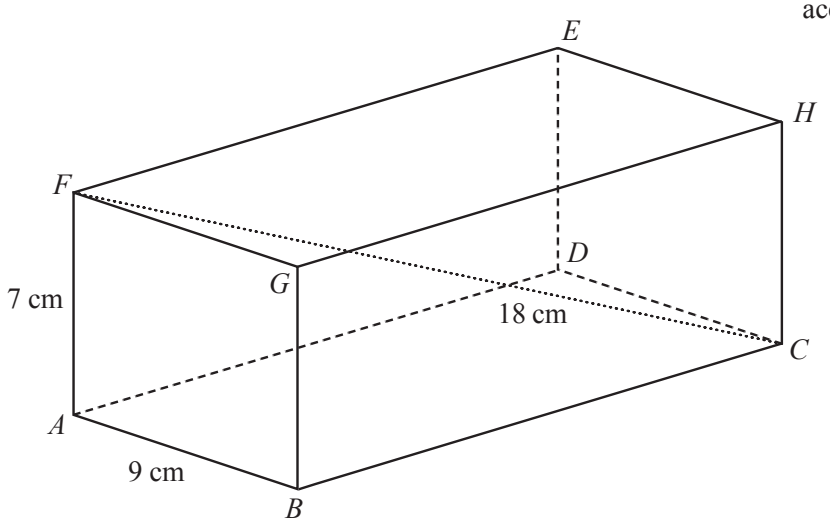
Calculate the value of h.
Give your answer correct to 3 significant figures.

h = ...

(Total for Question 2 is 3 marks)

20 The diagram shows cuboid *ABCDEFGH*

Diagram **NOT** accurately drawn



$AB = 9\,\text{cm}$ $AF = 7\,\text{cm}$ $FC = 18\,\text{cm}$

Calculate the length of *BC*
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 20 is 3 marks)

8 The diagram shows an isosceles triangle.

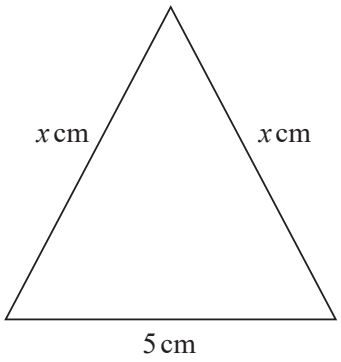


Diagram **NOT** accurately drawn

The area of the triangle is 12 cm^2

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

cm

(Total for Question 8 is 4 marks)

3

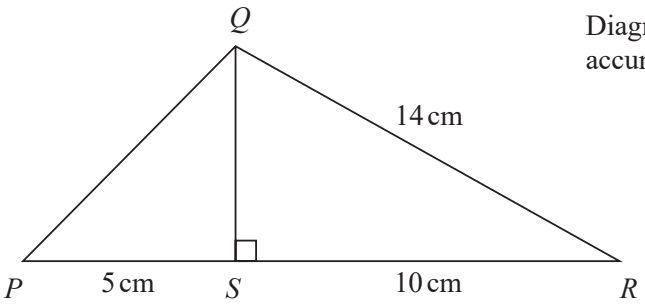


Diagram **NOT** accurately drawn

In triangle PQR,

S is the point on PR such that angle $RSQ = 90°$
$RQ = 14$ cm
$RS = 10$ cm
$SP = 5$ cm

Work out the length of PQ.

cm

(Total for Question 3 is 4 marks)

7 The diagram shows isosceles triangle ABC.

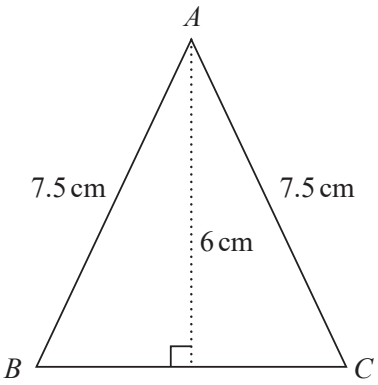


Diagram **NOT** accurately drawn

$AB = AC = 7.5$ cm.
The height of the triangle is 6 cm.

Calculate the area of the triangle.

..... cm^2

(Total for Question 7 is 4 marks)

8 The diagram shows an isosceles triangle.

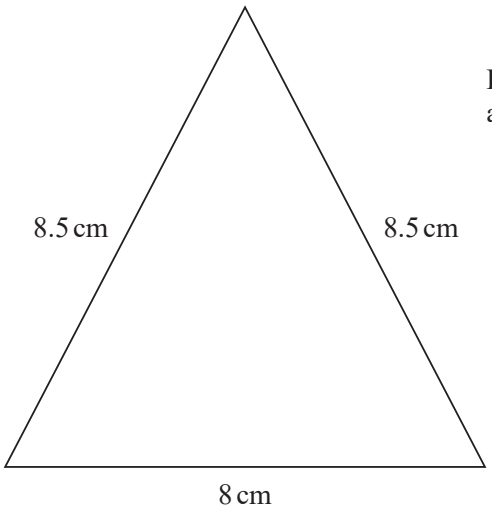


Diagram **NOT** accurately drawn

Work out the area of the triangle.

..... cm^2

(Total for Question 8 is 4 marks)

7 Markus makes a steel framework.
The framework is in the shape of the right-angled triangle ABC shown in the diagram.

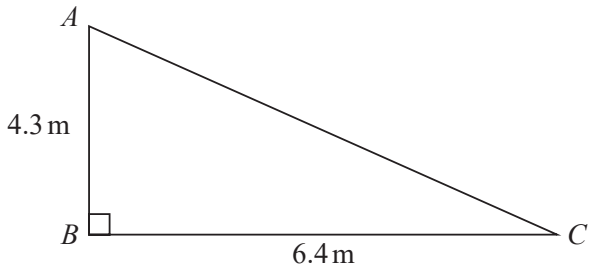


Diagram **NOT** accurately drawn

The steel that Markus uses costs $22 per metre.
The steel can **only** be bought in a length that is a whole number of metres.

Work out the total cost of the steel that Markus buys in order to make the framework.

$.....

(Total for Question 7 is 4 marks)

9 The diagram shows isosceles triangle ABC

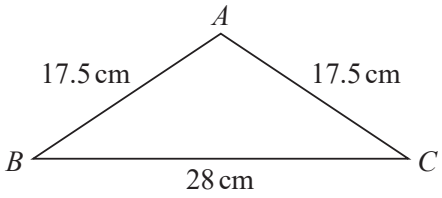


Diagram **NOT** accurately drawn

$AB = AC = 17.5$ cm $BC = 28$ cm

Calculate the area of triangle ABC

..... cm^2

(Total for Question 9 is 4 marks)

3 The shaded shape is made using three identical right-angled triangles and a square.

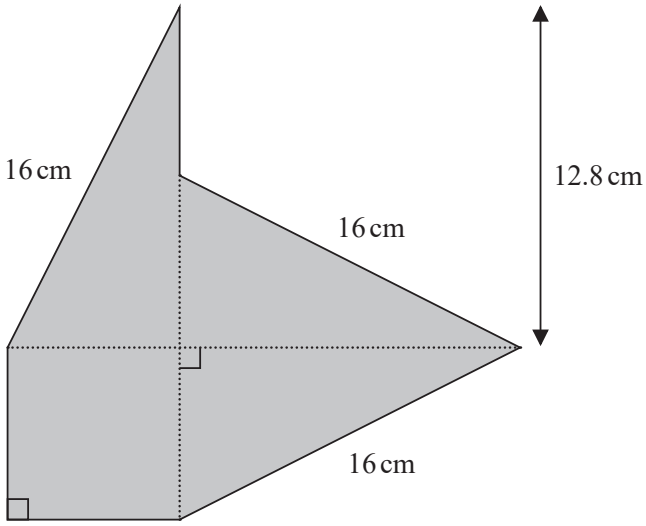


Diagram **NOT** accurately drawn

Work out the perimeter of the shaded shape.

..... cm

(Total for Question 3 is 4 marks)

5 The diagram shows a shaded shape *AEBCD* made by removing triangle *AEB* from rectangle *ABCD*

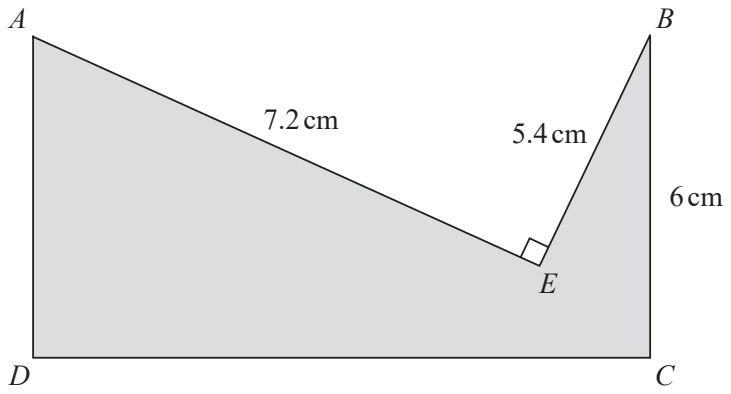


Diagram **NOT** accurately drawn

$AE = 7.2$ cm $BE = 5.4$ cm $BC = 6$ cm angle $AEB = 90°$

Work out the perimeter of the shaded shape.

..... cm

(Total for Question 5 is 4 marks)

11 The diagram shows a roof support.

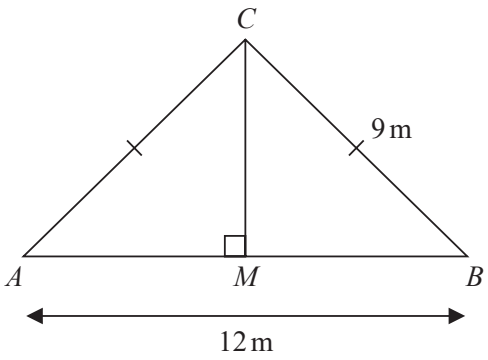


Diagram **NOT** accurately drawn

The roof support is made from four lengths of wood, AB, AC, BC and MC

$AC = BC = 9$ m $AB = 12$ m

angle $AMC = 90°$

Lewis is going to buy lengths of wood to make the roof support.

The wood costs 21.50 euros per metre.
Each length of wood he buys has to be a whole number of metres.

Work out the total cost of the wood Lewis needs to buy.
Show your working clearly.

..... euros

(Total for Question 11 is 4 marks)

10 The diagram shows an isosceles triangle, with base length 24 cm.

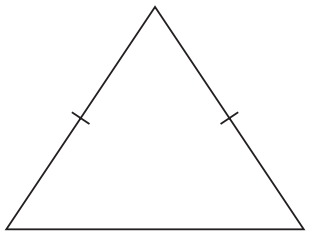


Diagram **NOT** accurately drawn

The perimeter of the triangle is 54 cm.

Work out the area of the triangle.

..... cm^2

(Total for Question 10 is 5 marks)

10 ABD and ABC are right-angled triangles.

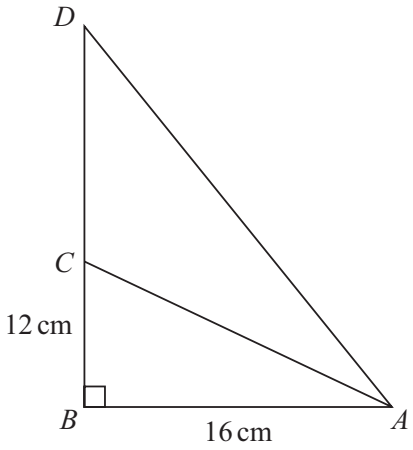


Diagram **NOT** accurately drawn

$AB = 16\,\text{cm}$ $BC = 12\,\text{cm}$ $AD = 1.5 \times AC$

Find the length of CD
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 10 is 5 marks)

11 The diagram shows two triangles, *ADE* and *CDB*

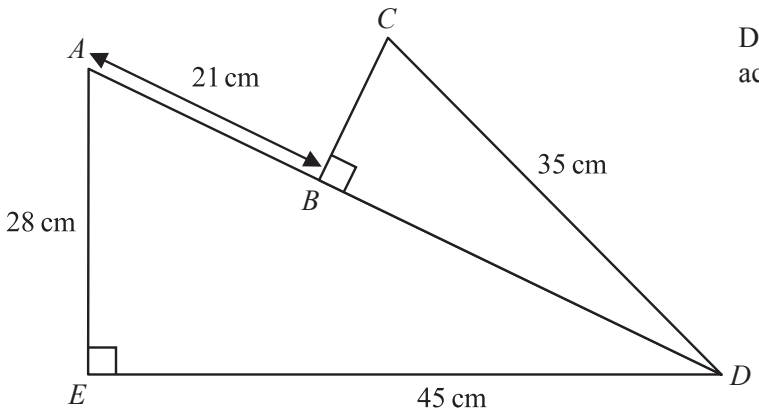


Diagram **NOT** accurately drawn

ABD is a straight line.

$AE = 28\,\text{cm}$ $ED = 45\,\text{cm}$ $AB = 21\,\text{cm}$ $CD = 35\,\text{cm}$

angle *AED* = angle *CBD* = 90°

Work out the area of triangle *CDB*
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 11 is 5 marks)

11 The diagram shows trapezium $ABCD$ in which BC and AD are parallel.

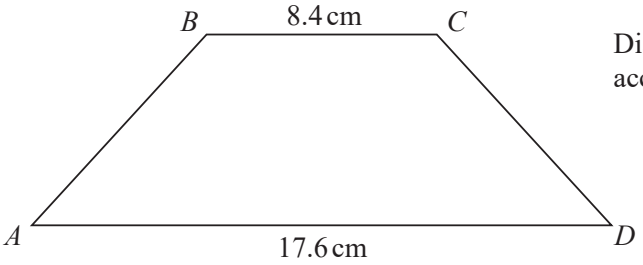


Diagram **NOT** accurately drawn

The trapezium has exactly one line of symmetry.

$BC = 8.4\,\text{cm}$
$AD = 17.6\,\text{cm}$

The trapezium has area $179.4\,\text{cm}^2$

Work out the size of angle ABC.
Give your answer correct to 1 decimal place.

.....°

(Total for Question 11 is 6 marks)

11 The diagram shows a quadrilateral $ABCD$

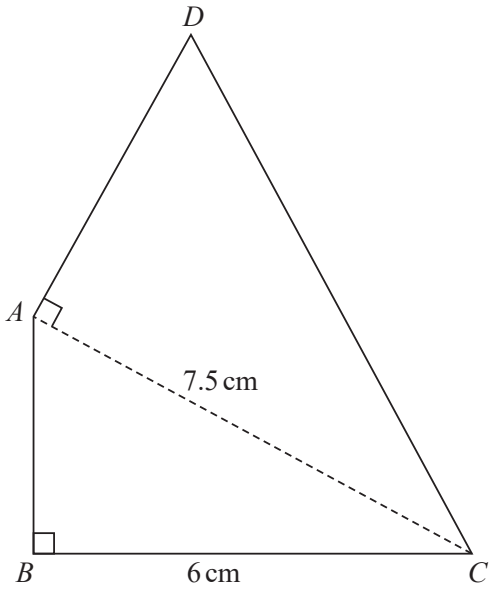


Diagram **NOT** accurately drawn

In the diagram, ABC and DAC are right-angled triangles.

$BC = 6\,\text{cm}$ $AC = 7.5\,\text{cm}$

The area of quadrilateral $ABCD$ is $31.5\,\text{cm}^2$

Work out the length of AD

Question 11 continued.

..... cm

(Total for Question 11 is 6 marks)

8 The diagram shows a trapezium, $ABCD$

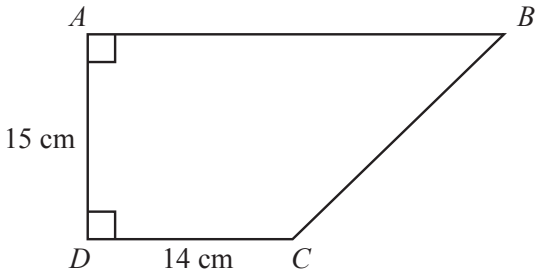


Diagram **NOT** accurately drawn

DAB and ADC are right angles.

$AD = 15$ cm $DC = 14$ cm

The area of the trapezium is 360 cm²

Work out the perimeter of the trapezium.

..... cm

(Total for Question 8 is 6 marks)

SUB-TOPIC G5b

RIGHT-ANGLED TRIGONOMETRY & EXACT VALUES

Sub-topic G5b · 26 questions · 100 marks · lowest tariff first

8

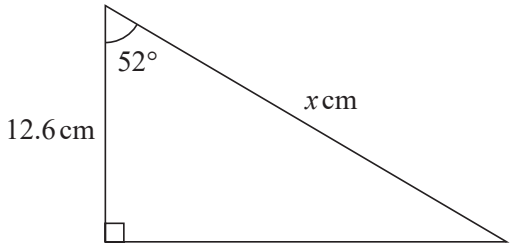


Diagram **NOT** accurately drawn

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

$x =$ .....

(Total for Question 8 is 3 marks)

9 Solve the simultaneous equations

$$x + y = 15$$
$$7x - 5y = 3$$

Show clear algebraic working.

$x =$ .....

$y =$ .....

(Total for Question 9 is 3 marks)

7 The diagram shows a right-angled triangle.

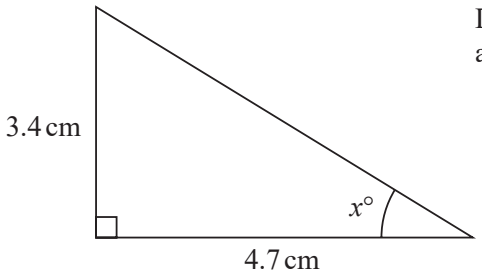


Diagram **NOT** accurately drawn

Calculate the value of x.
Give your answer correct to one decimal place.

$x =$ .....

(Total for Question 7 is 3 marks)

13 The diagram shows two hot air balloons.
A is a point on the base of one of the balloons and B is a point on the base of the other balloon.

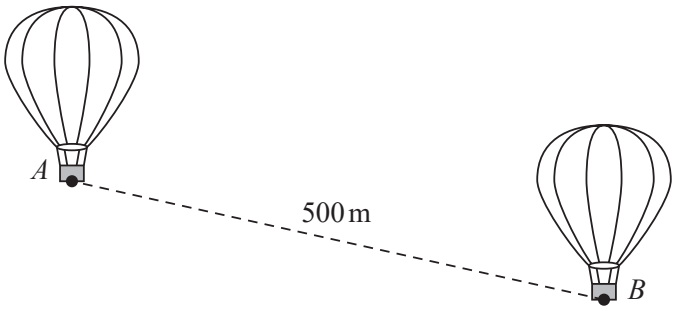


Diagram **NOT** accurately drawn

The distance between A and B is 500 metres.
The angle of depression of B from A is 23°

Calculate the vertical height of A above B.
Give your answer correct to one decimal place.

..... metres

(Total for Question 13 is 3 marks)

7 Here is a right-angled triangle.

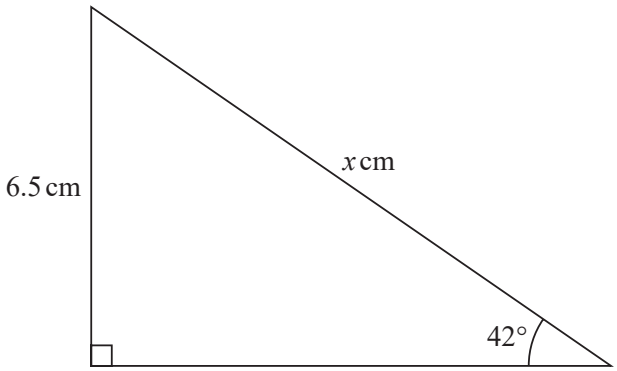


Diagram **NOT** accurately drawn

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

$x =$ .....

(Total for Question 7 is 3 marks)

2 Danil, Gabriel and Hadley share some money in the ratios 3 : 5 : 9
The difference between the amount of money that Gabriel receives and the amount of money that Hadley receives is 196 euros.

Work out the amount of money that Danil receives.

..... euros

(Total for Question 2 is 3 marks)

3 The diagram shows triangle ABC

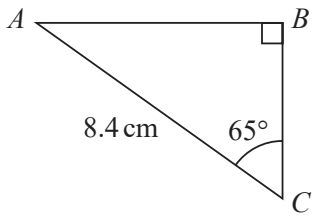


Diagram **NOT** accurately drawn

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

..... cm

(Total for Question 3 is 3 marks)

14 A zip wire is shown as the dashed line AC in the diagram.

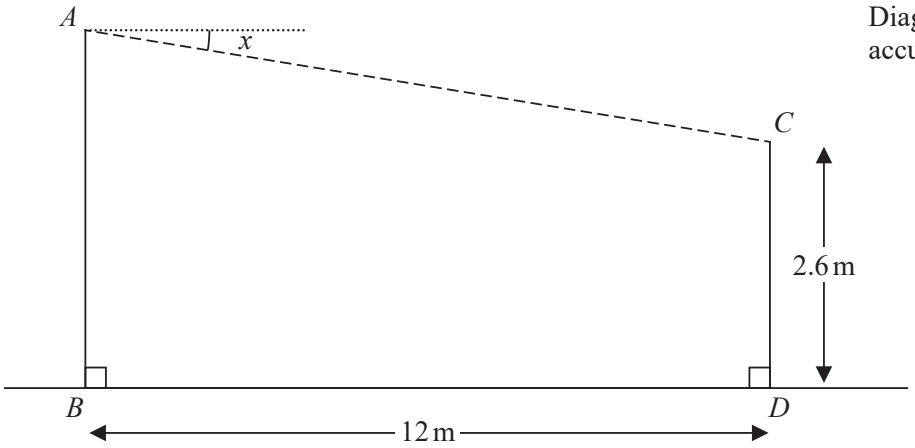


Diagram **NOT** accurately drawn

The zip wire is supported by two vertical posts AB and CD standing on horizontal ground.

$CD = 2.6\,\text{m}$ $BD = 12\,\text{m}$

The zip wire makes an angle x with the horizontal, as shown in the diagram.
The design of the zip wire requires the angle x to be at least 5°

Work out the least possible height of the post AB
Give your answer correct to 3 significant figures.

..... m

(Total for Question 14 is 3 marks)

12 The diagram shows two vertical phone masts, AB and CD, on horizontal ground.

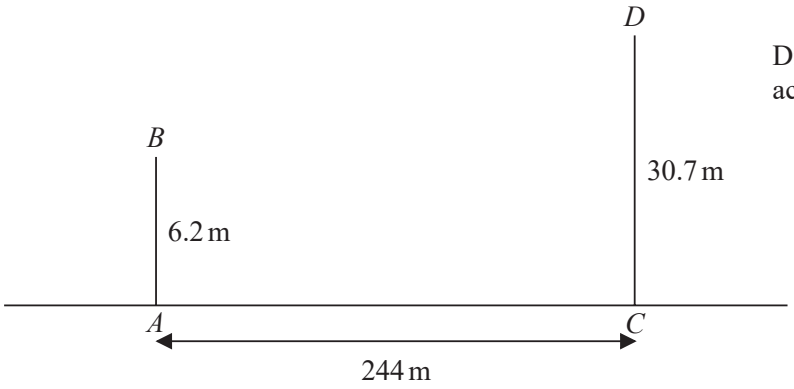


Diagram **NOT** accurately drawn

$AB = 6.2\,\text{m}$ $AC = 244\,\text{m}$ $CD = 30.7\,\text{m}$

Work out the size of the angle of depression of B from D
Give your answer correct to one decimal place.

.....°

(Total for Question 12 is 3 marks)

6 The diagram shows triangle PQR.

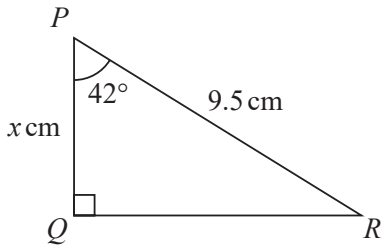


Diagram **NOT** accurately drawn

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

$x =$ .....

(Total for Question 6 is 3 marks)

7 Change a speed of 81 kilometres per hour to a speed in metres per second.

..... metres per second

(Total for Question 7 is 3 marks)

5 The diagram shows triangle ABC

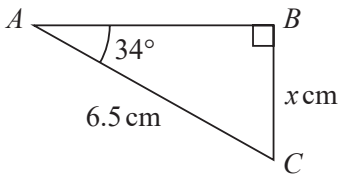


Diagram **NOT** accurately drawn

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

$x =$ .....

(Total for Question 5 is 3 marks)

6 Change a speed of w metres per second to a speed in kilometres per hour.
Give your answer in terms of w in its simplest form.

..... kilometres per hour

(Total for Question 6 is 3 marks)

3 The diagram shows triangle PQR

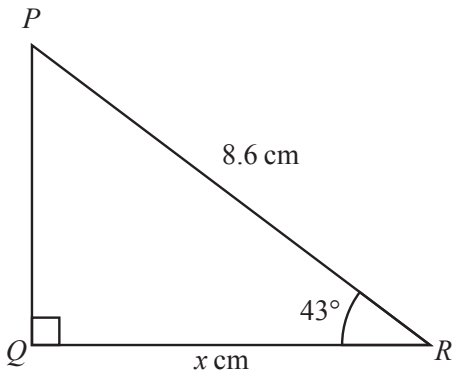


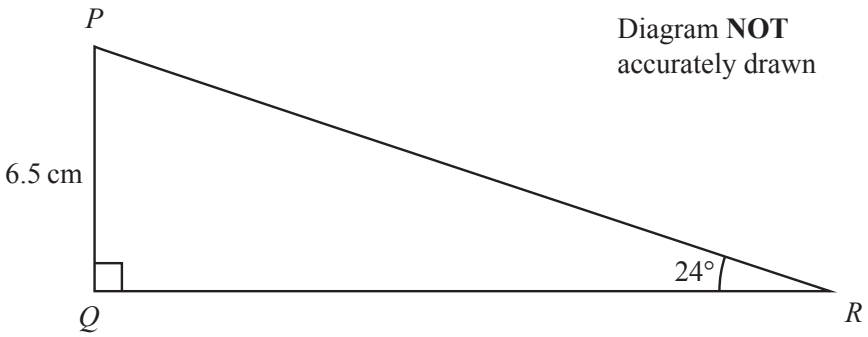
Diagram **NOT** accurately drawn

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

$x =$ .....

(Total for Question 3 is 3 marks)

9 The diagram shows triangle PQR



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

..... cm

(Total for Question 9 is 3 marks)

10 *ABCD* is a trapezium.

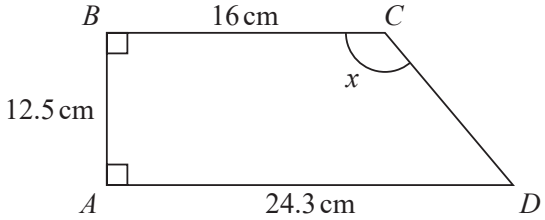


Diagram **NOT** accurately drawn

Work out the size of angle x.
Give your answer correct to 1 decimal place.

.....°

(Total for Question 10 is 4 marks)

7 The diagram shows a trapezium.

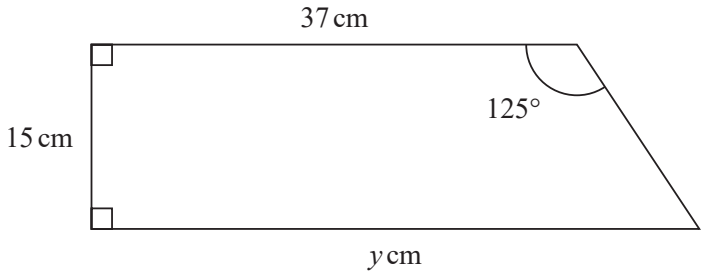


Diagram **NOT** accurately drawn

Work out the value of y.
Give your answer correct to 1 decimal place.

$y =$

(Total for Question 7 is 4 marks)

12 *ABCD* is a trapezium.

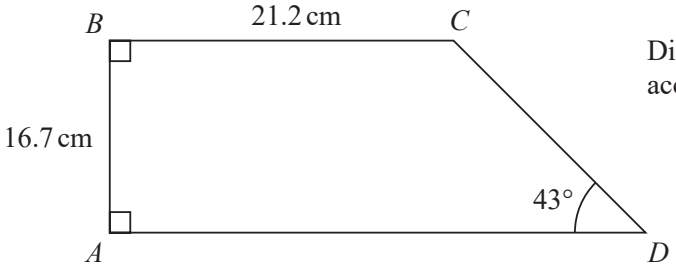


Diagram **NOT** accurately drawn

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

..... cm

(Total for Question 12 is 4 marks)

15 The diagram shows two right-angled triangles, *DEF* and *EFG*.

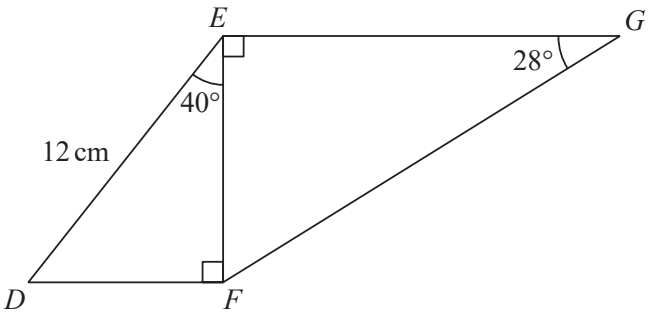


Diagram **NOT** accurately drawn

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

..... cm

(Total for Question 15 is 4 marks)

10 Here is isosceles triangle ABC.

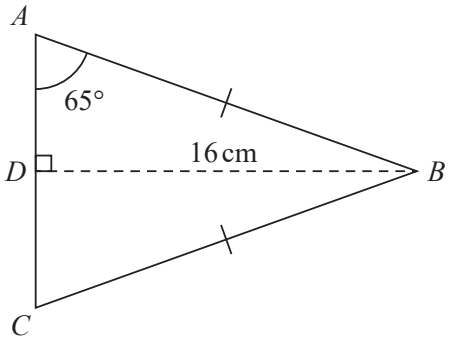


Diagram **NOT** accurately drawn

D is the midpoint of AC and $DB = 16$ cm.

Angle $DAB = 65°$

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

..... cm

(Total for Question 10 is 4 marks)

10 ABC is an isosceles triangle with $BA = BC$.

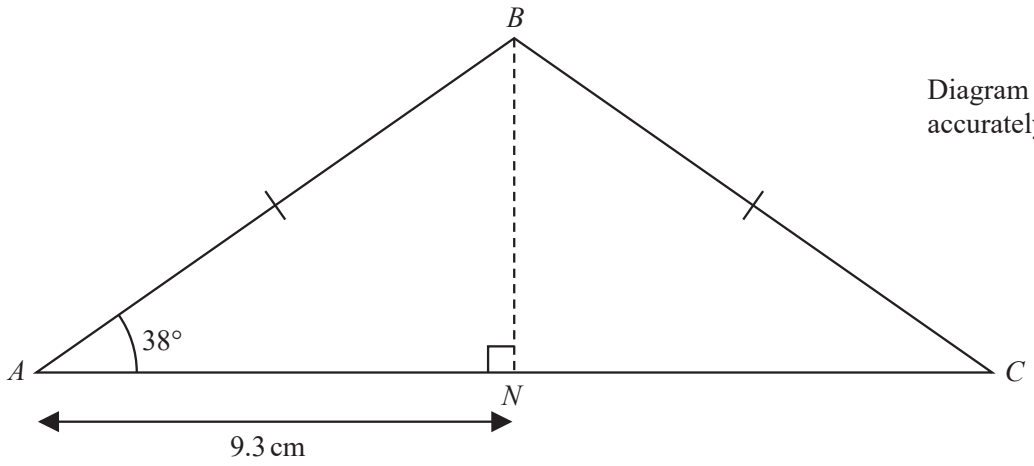


Diagram **NOT** accurately drawn

N is the point on AC such that $AN = 9.3$ cm and BN is perpendicular to AC.

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

..... cm

(Total for Question 10 is 4 marks)

10 R and T are points on a circle, centre O

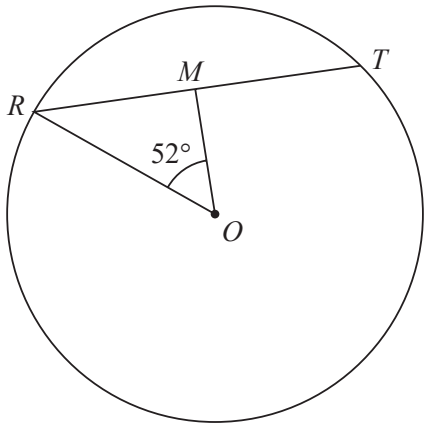


Diagram **NOT** accurately drawn

$RT = 12$ cm
M is the midpoint of RT
Angle $ROM = 52°$

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

..... cm^2

(Total for Question 10 is 4 marks)

12 The diagram shows right-angled triangle ABD

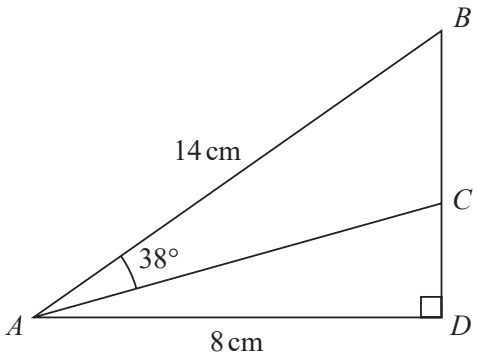


Diagram **NOT** accurately drawn

$AB = 14$ cm $AD = 8$ cm

C is the point on BD such that angle $BAC = 38°$

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

..... cm

(Total for Question 12 is 4 marks)

12 ABC is a right-angled triangle.
D is a point on BC

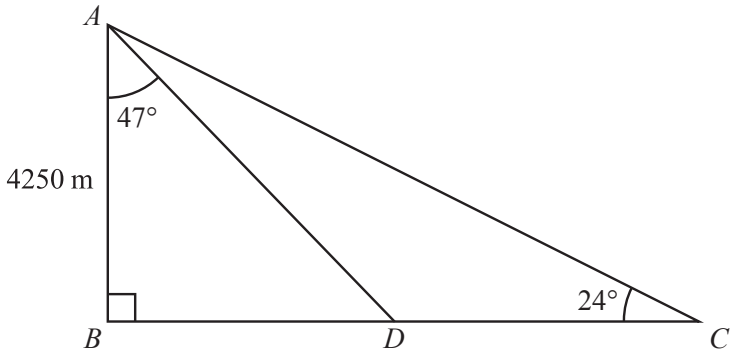


Diagram **NOT** accurately drawn

$AB = 4250$ m angle $BAD = 47°$ angle $BCA = 24°$

Work out the length of DC
Give your answer correct to the nearest integer.

..... m

(Total for Question 12 is 4 marks)

9 The diagram shows a right-angled triangle.

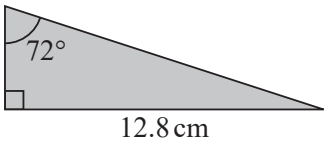


Diagram **NOT** accurately drawn

Five of these triangles are put together to make a shape.

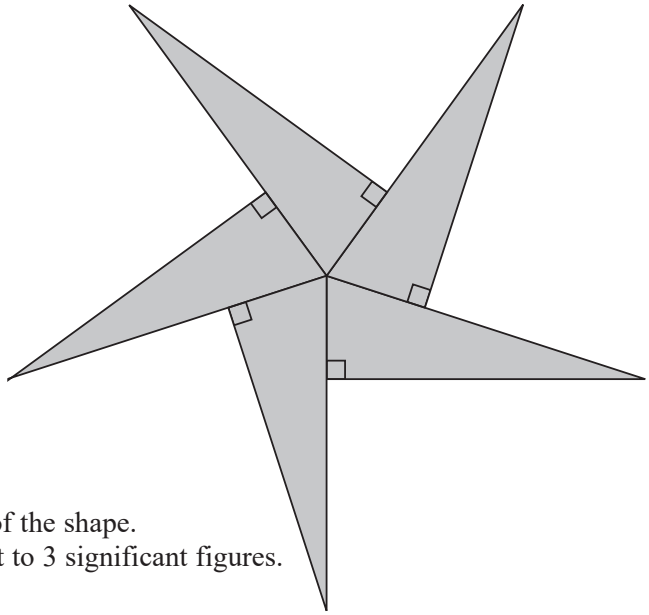


Diagram **NOT** accurately drawn

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

..... cm

(Total for Question 9 is 5 marks)

10 Here is triangle ABD.

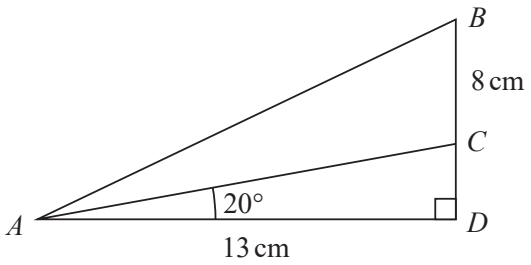


Diagram **NOT** accurately drawn

The point C lies on BD.

$AD = 13$ cm $BC = 8$ cm angle $ADB = 90°$ angle $CAD = 20°$

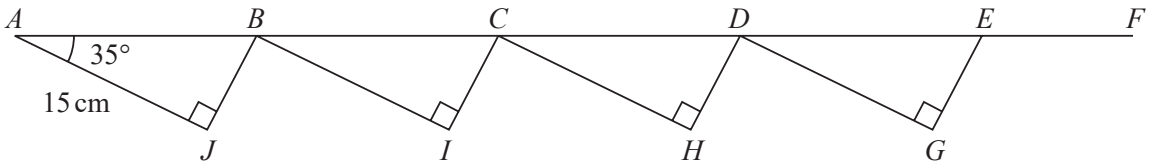
Calculate the size of angle BAC.
Give your answer correct to 1 decimal place.

°

(Total for Question 10 is 5 marks)

13 The diagram shows four congruent right-angled triangles *ABJ*, *BCI*, *CDH* and *DEG*.
The diagram also shows the straight line *ABCDEF*.

Diagram **NOT** accurately drawn



AJ = 15 cm
Angle *BAJ* = 35°

AF = 80 cm

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

..... cm

(Total for Question 13 is 5 marks)

10 The diagram shows triangle ABP inside the regular hexagon $ABCDEF$

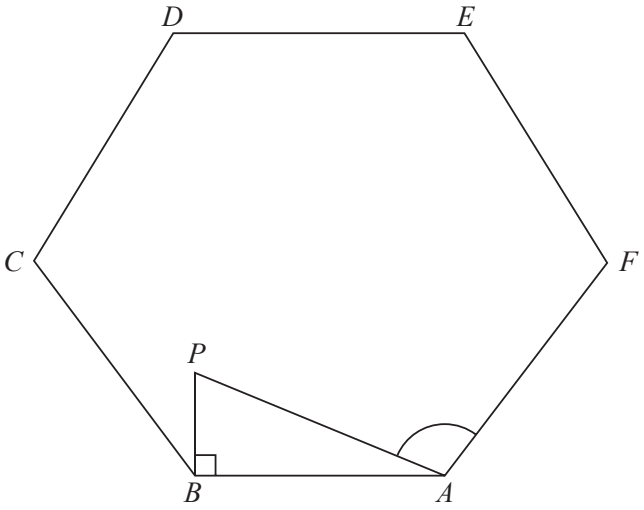


Diagram **NOT** accurately drawn

$AB = 5\,\text{cm}$ $BP = 2\,\text{cm}$ Angle $ABP = 90°$

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

.....°

(Total for Question 10 is 5 marks)

8 The diagram shows a triangle ABC inside a semicircle.

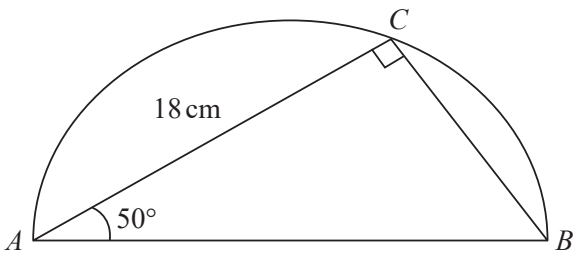


Diagram **NOT** accurately drawn

A, B and C are points on the semicircle.

AB is the diameter of the semicircle.

Angle $ACB = 90°$
Angle $BAC = 50°$
$AC = 18$ cm

Work out the perimeter of the semicircle.
Give your answer correct to 2 significant figures.

..... cm

(Total for Question 8 is 5 marks)

9 (a) Write 6.25×10^{-4} as an ordinary number.

.....

(1)

(b) Work out $(2.4 \times 10^{12}) \div (9.6 \times 10^{4})$
Give your answer in standard form.

.....

(2)

(Total for Question 9 is 3 marks)

12 The diagram shows a vertical cliff with a vertical radio mast on top of the cliff and a buoy in the sea.

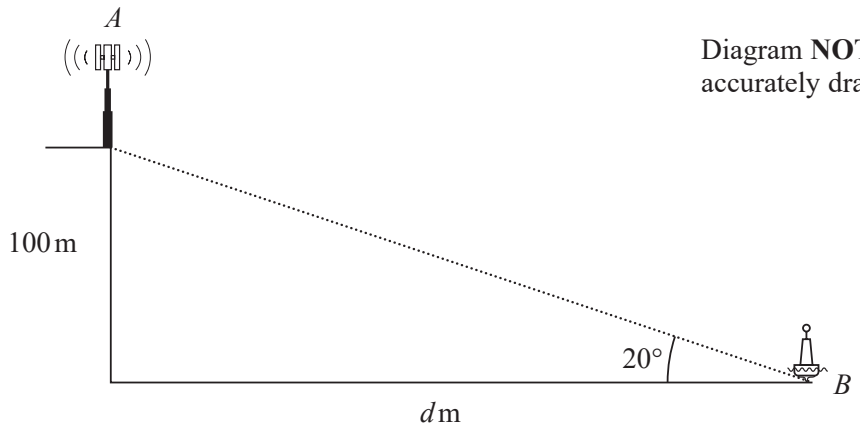


Diagram **NOT** accurately drawn

The height of the cliff is 100 metres.
The buoy is at the point B that is d metres from the base of the cliff.
The angle of elevation from B to the top of the cliff is 20°

(a) Calculate the value of d.
Give your answer correct to 3 significant figures.

$d =$ .....

(3)

The point A at the top of the radio mast is vertically above the top of the cliff.
The angle of elevation from B to A is 25°

(b) Calculate the height of the radio mast.
Give your answer correct to 3 significant figures.

..... m

(3)

(Total for Question 12 is 6 marks)

SUB-TOPIC G5c

SINE RULE, COSINE RULE & AREA OF A TRIANGLE

Sub-topic G5c · 25 questions · 121 marks · lowest tariff first

18 A triangle has sides of length 8 cm, 10 cm and 14 cm.

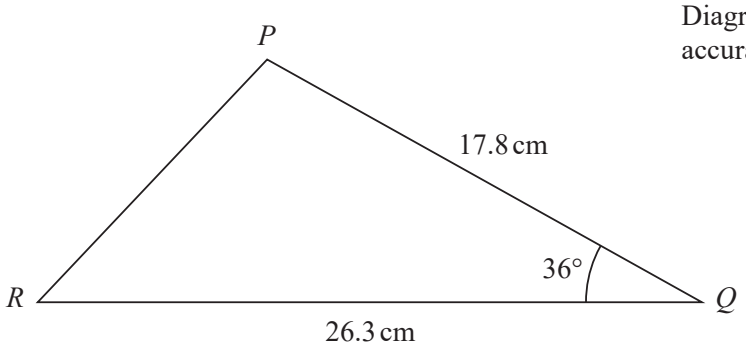
Work out the size of the largest angle of the triangle.
Give your answer correct to 1 decimal place.

.....°

(Total for Question 18 is 3 marks)

18 The diagram shows triangle PQR.

Diagram **NOT** accurately drawn



Calculate the length of PR.
Give your answer correct to 3 significant figures.

..... cm

(Total for Question 18 is 3 marks)

15 The diagram shows a kite $ABCD$

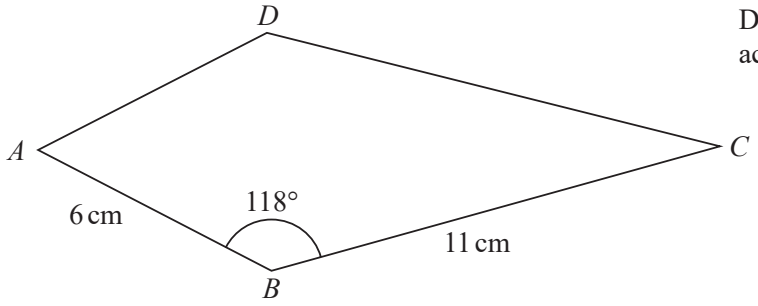


Diagram **NOT** accurately drawn

$AB = 6$ cm $BC = 11$ cm Angle $ABC = 118°$

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

..... cm^2

(Total for Question 15 is 3 marks)

15 The diagram shows isosceles triangle *EFG*

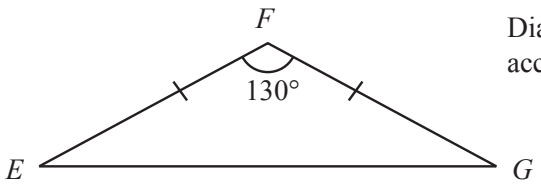


Diagram **NOT** accurately drawn

EF = *GF*
Angle *EFG* = 130°
The area of triangle *EFG* is 74 cm²

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

..... cm

(Total for Question 15 is 3 marks)

15

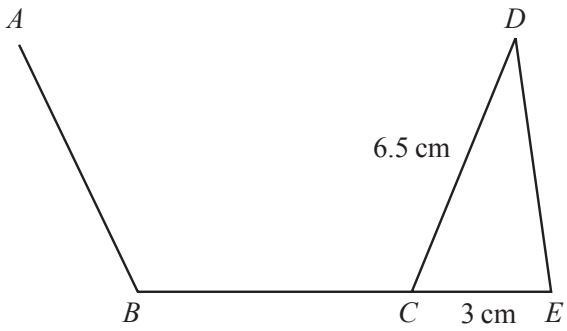


Diagram **NOT** accurately drawn

AB, *BC* and *CD* are three sides of a regular pentagon and *CDE* is a triangle.
BCE is a straight line.

$CD = 6.5$ cm $CE = 3$ cm

Work out the area of triangle *CDE*
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 15 is 3 marks)

17 Here is triangle ABC.

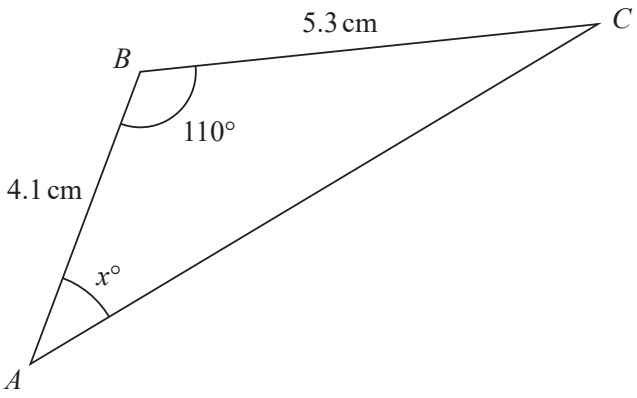


Diagram **NOT** accurately drawn

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

(Total for Question 17 is 5 marks)

21 Here is a triangle XYZ.

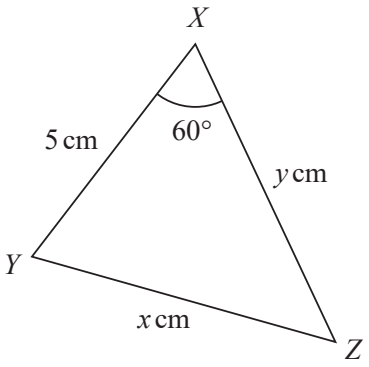


Diagram **NOT** accurately drawn

The perimeter of the triangle is k cm.

Given that $x = y - 1$
find the value of k.
Show your working clearly.

$k =$

(Total for Question 21 is 5 marks)

19 *ABCD* is a quadrilateral.

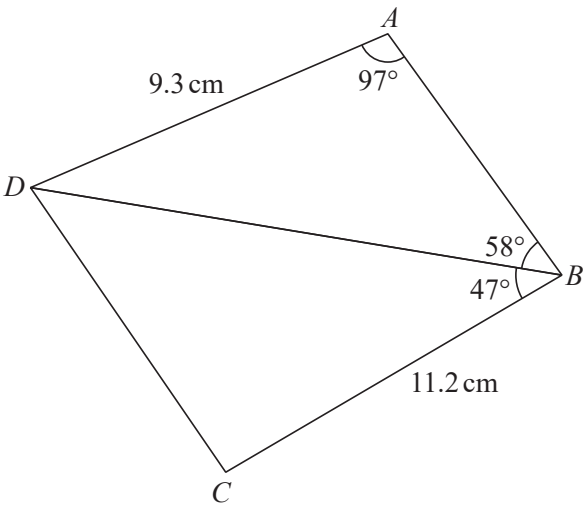


Diagram **NOT** accurately drawn

Find the area of quadrilateral *ABCD*.
Give your answer correct to 3 significant figures.

cm^2

(Total for Question 19 is 5 marks)

12

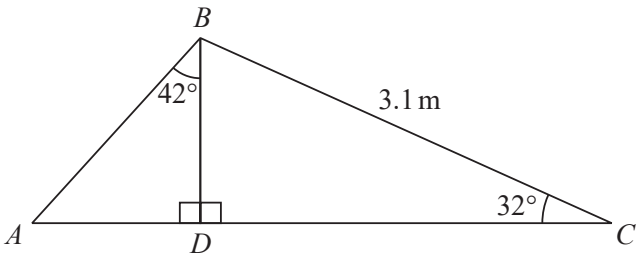


Diagram **NOT** accurately drawn

Calculate the length of AB.
Show your working clearly.
Give your answer correct to 3 significant figures.

..... m

(Total for Question 12 is 5 marks)

14 The diagram shows parallelogram *EFGH*.

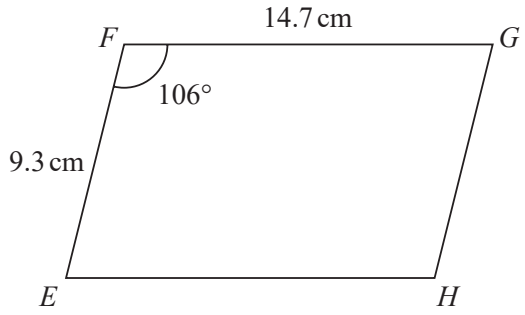


Diagram **NOT** accurately drawn

EF = 9.3 cm
FG = 14.7 cm
Angle *EFG* = 106°

(a) Work out the area of the parallelogram.
Give your answer correct to 3 significant figures.

..... cm^2
(2)

(b) Work out the length of the diagonal *EG* of the parallelogram.
Give your answer correct to 3 significant figures.

..... cm
(3)

(Total for Question 14 is 5 marks)

18 Here is a quadrilateral *ABCD*.

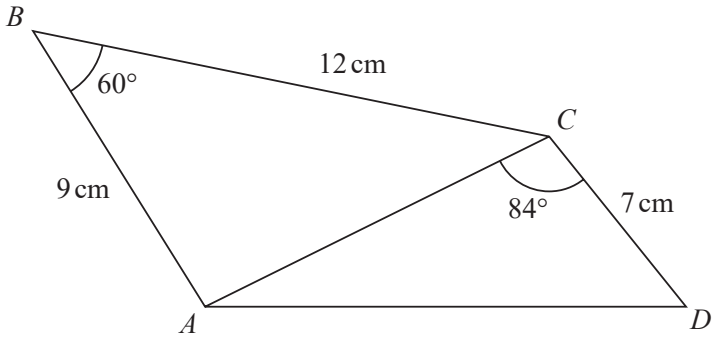


Diagram **NOT** accurately drawn

Calculate the area of quadrilateral *ABCD*.
Give your answer correct to 3 significant figures.
Show your working clearly.

..... cm^2

(Total for Question 18 is 5 marks)

16 The diagram shows quadrilateral *ABCD*

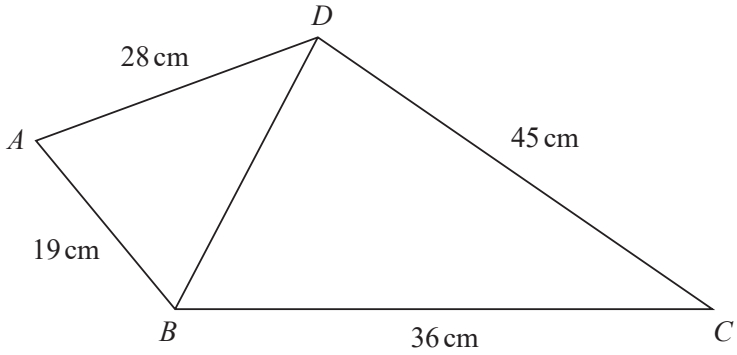


Diagram **NOT** accurately drawn

The angle *BCD* is acute.

Given that the area of triangle *BCD* = 405 cm^2

work out the size of angle *ABD*
Give your answer correct to one decimal place.

.....°

(Total for Question 16 is 5 marks)

18 Here is triangle ABC

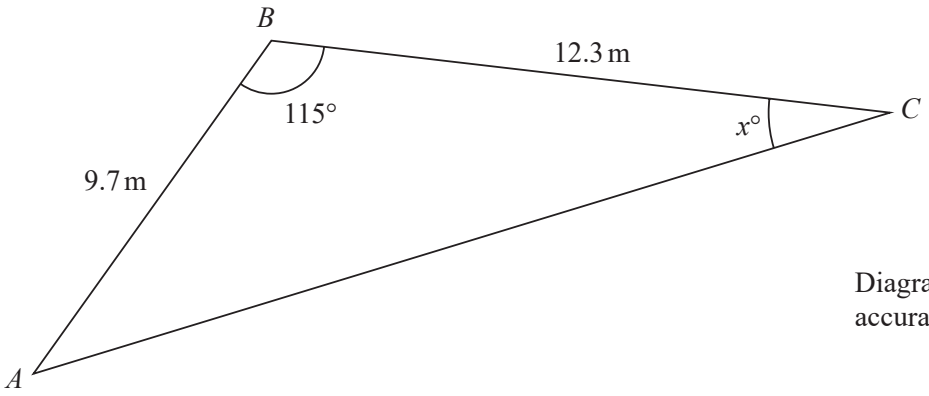


Diagram **NOT** accurately drawn

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

$x =$ .....

(Total for Question 18 is 5 marks)

17 Here is a parallelogram $PQRS$, in which angle SPQ is acute.

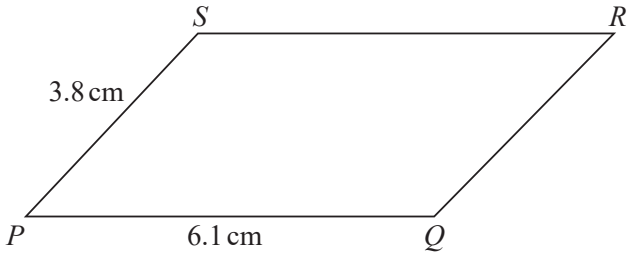


Diagram **NOT** accurately drawn

$PQ = 6.1$ cm $PS = 3.8$ cm

The area of the parallelogram is $18\,\text{cm}^2$

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

..... cm

(Total for Question 17 is 5 marks)

16 Here is a shape formed from two triangles ABC and CDE
ACD and BCE are straight lines.

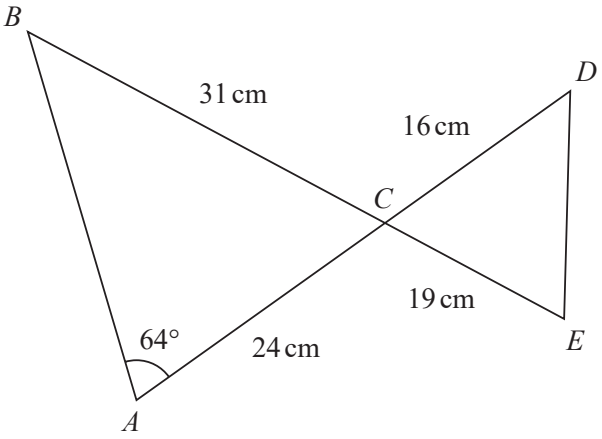


Diagram **NOT** accurately drawn

$AC = 24\,\text{cm}$ $BC = 31\,\text{cm}$ $CE = 19\,\text{cm}$ $CD = 16\,\text{cm}$

Angle $BAC = 64°$

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

..... cm

(Total for Question 16 is 5 marks)

17 y is inversely proportional to $\sqrt{x}$

$y = c^4$ when $x = c^2$ where c is a positive constant.

Find a formula for y in terms of x and c
Give your answer in its simplest form.

.....

(Total for Question 17 is 3 marks)

17

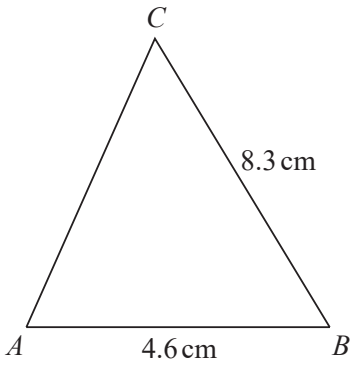


Diagram **NOT** accurately drawn

$AB = 4.6\,\text{cm}$ $BC = 8.3\,\text{cm}$ angle ABC is acute

The area of triangle ABC is $12\,\text{cm}^2$

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

..... cm

(Total for Question 17 is 5 marks)

10 Here is triangle ABC

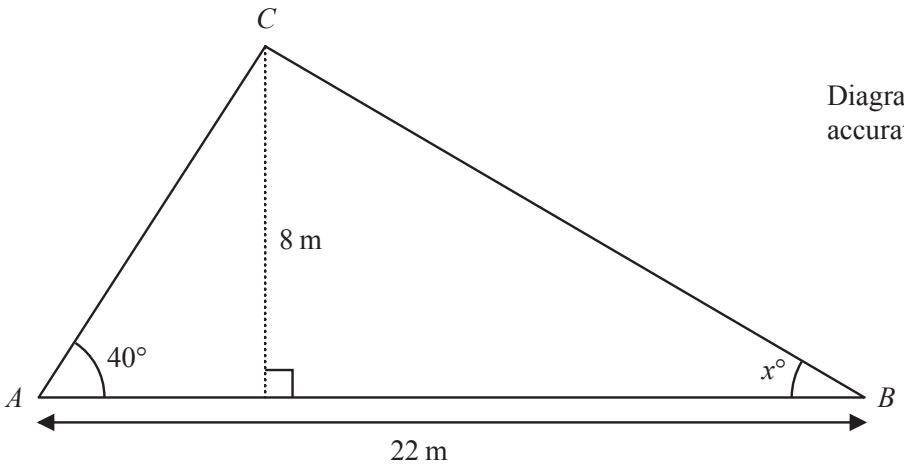


Diagram **NOT** accurately drawn

Work out the value of x
Give your answer correct to one decimal place.
Show your working clearly.

$x =$ .....

(Total for Question 10 is 5 marks)

19 Here is quadrilateral $ABCD$

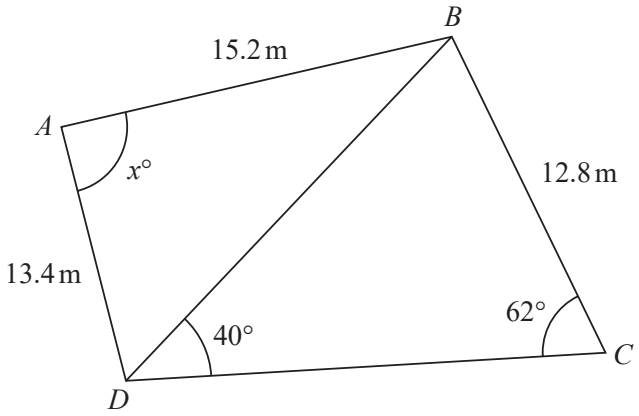


Diagram **NOT** accurately drawn

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

$x =$ .....

(Total for Question 19 is 5 marks)

20

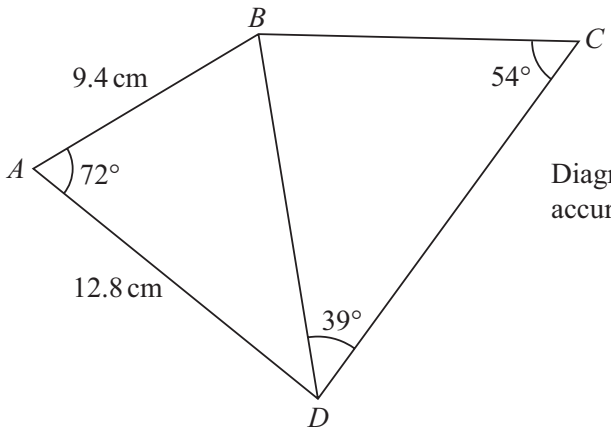


Diagram **NOT** accurately drawn

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

..... cm

(Total for Question 20 is 5 marks)

18 Here is a quadrilateral *PQRS*.

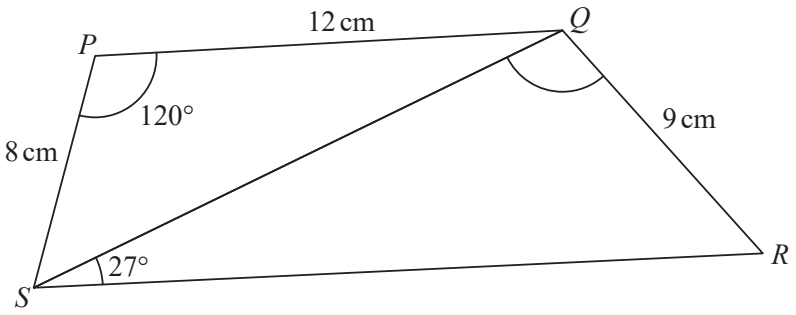


Diagram **NOT** accurately drawn

Angle *SRQ* is acute.

Work out the size of angle *SQR*.
Give your answer correct to 1 decimal place.

.....°

(Total for Question 18 is 6 marks)

19 *ABCD* is a quadrilateral.

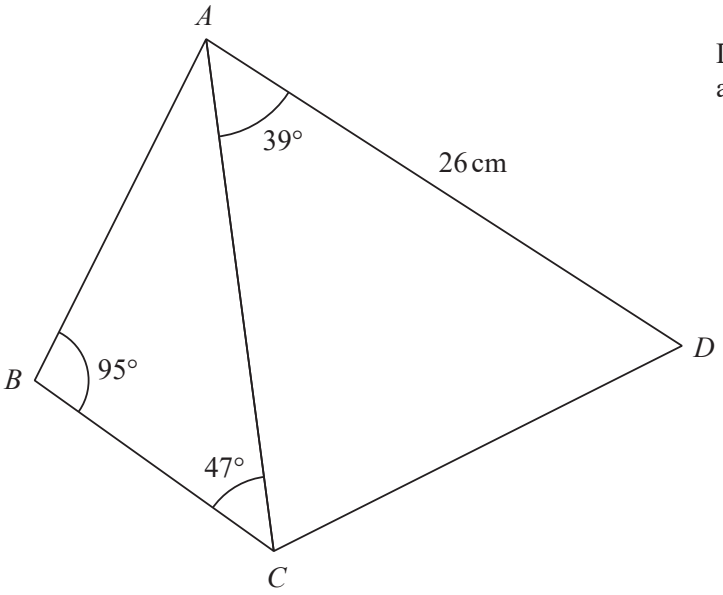


Diagram **NOT** accurately drawn

The area of triangle *ACD* is 250 cm^2

Calculate the area of the quadrilateral *ABCD*.
Show your working clearly.
Give your answer correct to 3 significant figures.

.....cm^2

(Total for Question 19 is 6 marks)

21 The diagram shows the prism $ABCDEF$ with cross section triangle ABC.

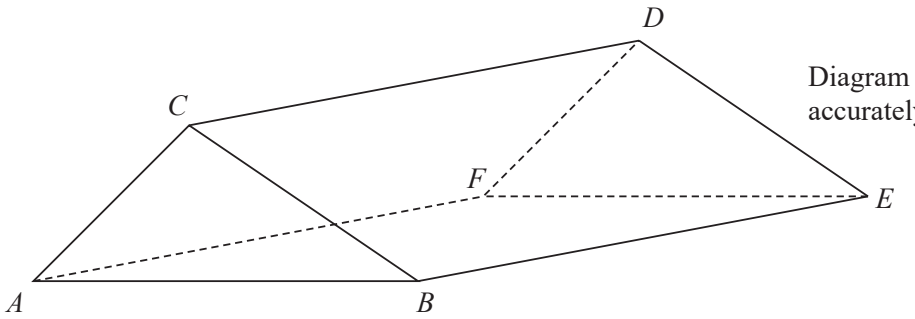


Diagram **NOT** accurately drawn

Angle $BEC = 40°$ and angle ACB is obtuse.
$AC = 6\,\text{cm}$ and $CE = 13\,\text{cm}$

The area of triangle ABC is $22\,\text{cm}^2$

Calculate the length of AB.
Give your answer correct to one decimal place.

..... cm

(Total for Question 21 is 6 marks)

18

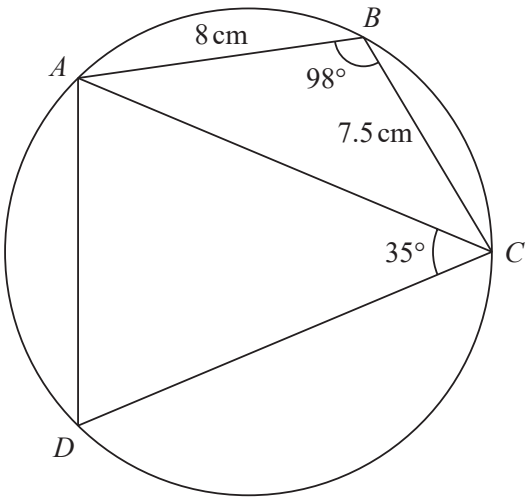


Diagram **NOT** accurately drawn

ABCD is a quadrilateral where *A*, *B*, *C* and *D* are points on a circle.

AB = 8 cm
BC = 7.5 cm
Angle *ABC* = 98°
Angle *ACD* = 35°

Work out the perimeter of quadrilateral *ABCD*.
Give your answer correct to one decimal place.

..... cm

(Total for Question 18 is 6 marks)

23 The diagram shows triangle PQR

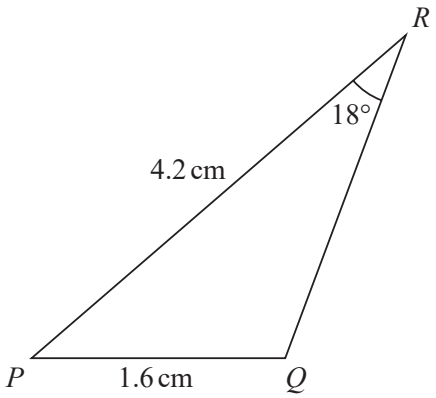


Diagram **NOT** accurately drawn

$PQ = 1.6$ cm $PR = 4.2$ cm Angle $PRQ = 18°$

Given that angle PQR is obtuse,

work out the area of triangle PQR
Give your answer correct to 3 significant figures.

..... cm^2

(Total for Question 23 is 6 marks)

25 Here is a triangle ABC

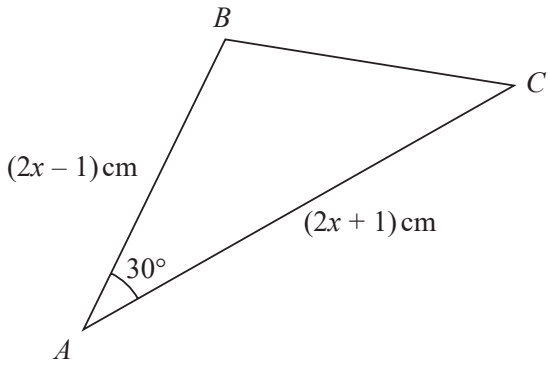


Diagram **NOT** accurately drawn

The area of the triangle is $(x^2 + x - 3.75)\,\text{cm}^2$

Find the size of the largest angle in triangle ABC
Give your answer correct to the nearest degree.

.....°

(Total for Question 25 is 6 marks)

TOTAL FOR PAPER IS 100 MARKS

SUB-TOPIC G5d

3D PYTHAGORAS & TRIGONOMETRY

Sub-topic G5d · 19 questions · 85 marks · lowest tariff first

19 The diagram shows a triangular prism.

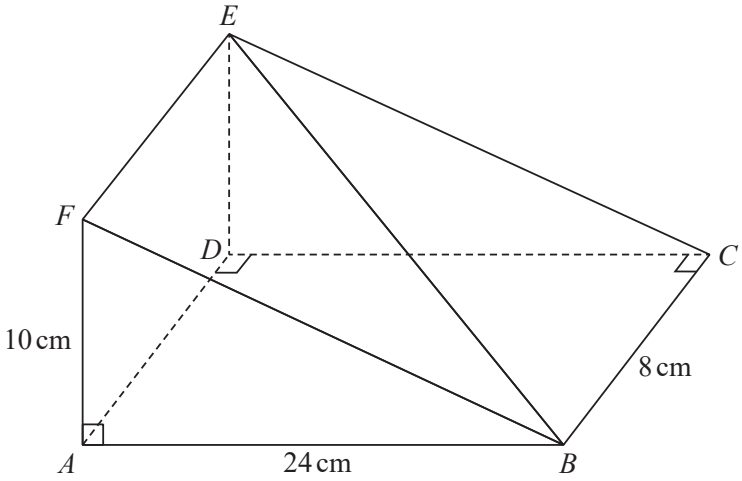


Diagram **NOT** accurately drawn

$AF = 10$ cm, $AB = 24$ cm and $BC = 8$ cm.
Angle FAB = angle ADC = angle $BCD = 90°$

Work out the size of the angle between the line BE and the plane $ABCD$.
Give your answer correct to 1 decimal place.

.....°

(Total for Question 19 is 3 marks)

21 The diagram shows cuboid *ABCDEFGH*.

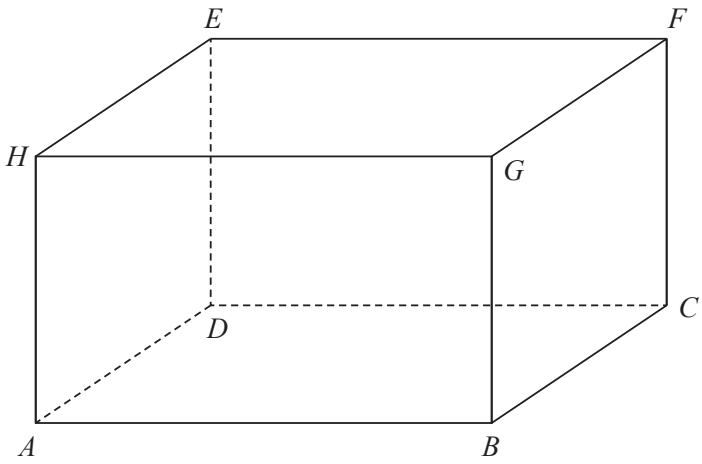


Diagram **NOT** accurately drawn

For this cuboid

the length of *AB* : the length of *BC* : the length of *CF* = 4 : 2 : 3

Calculate the size of the angle between *AF* and the plane *ABCD*.
Give your answer correct to one decimal place.

.....°

(Total for Question 21 is 3 marks)

19 *ABCD* is a horizontal rectangular field.

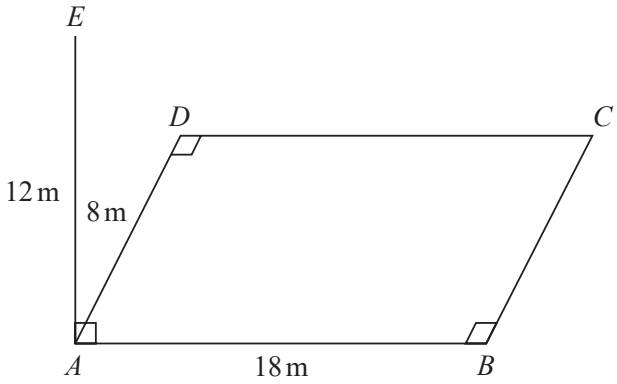


Diagram **NOT** accurately drawn

A vertical pole, *AE*, is placed at the corner *A* of the field.

$AE = 12\,\text{m}$ $AB = 18\,\text{m}$ $AD = 8\,\text{m}$

Calculate the size of the angle between *EC* and the plane *ABCD*
Give your answer correct to one decimal place.

.....°

(Total for Question 19 is 3 marks)

23 The diagram shows a triangular prism, *ABCDEF*, with a horizontal rectangular base *ABCD*

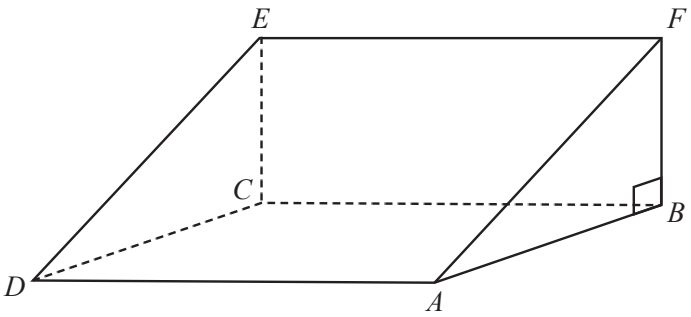


Diagram **NOT** accurately drawn

M is the midpoint of the line *AC*

AC = 40 cm angle *CAE* = 35° angle *ABF* = 90°

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

.....°

(Total for Question 23 is 3 marks)

20 Here is a cube *ABCDEFGH*.

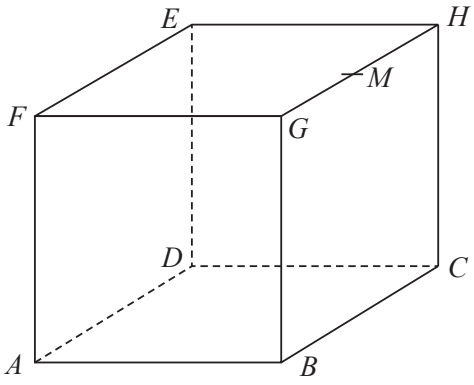


Diagram **NOT** accurately drawn

M is the midpoint of the edge *GH*.

Find the size of the angle between the line *MA* and the plane *ABCD*.
Give your answer correct to 1 decimal place.

°

(Total for Question 20 is 4 marks)

19 The diagram shows a cuboid *ABCDEFGH*.

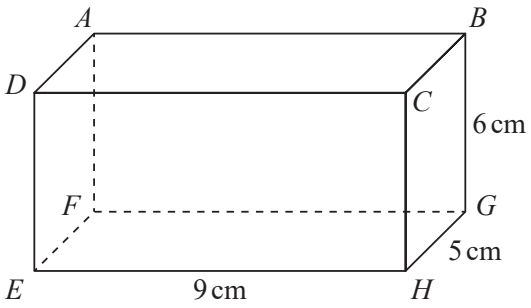


Diagram **NOT** accurately drawn

$EH = 9\,\text{cm}$, $HG = 5\,\text{cm}$ and $GB = 6\,\text{cm}$.

Work out the size of the angle between AH and the plane $EFGH$.
Give your answer correct to 3 significant figures.

.....°

(Total for Question 19 is 4 marks)

22 ABC is an isosceles triangle in a horizontal plane.
The point T is vertically above B.

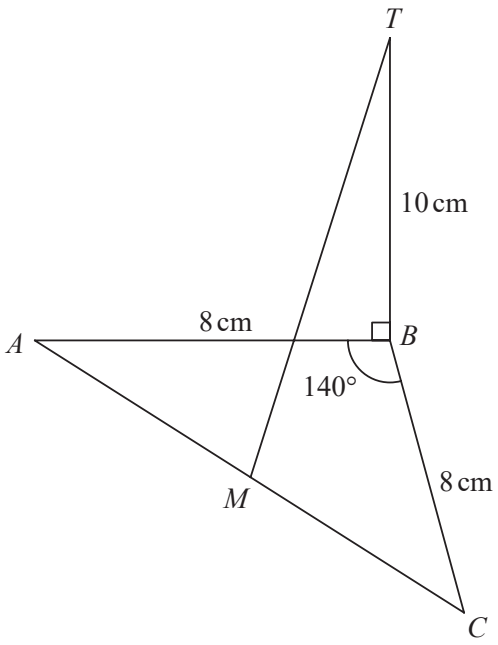


Diagram **NOT** accurately drawn

Angle $ABC = 140°$
$AB = BC = 8$ cm
$TB = 10$ cm
M is the midpoint of AC.

Calculate the size of the angle between MT and the horizontal plane ABC.
Give your answer correct to one decimal place.

.....°

(Total for Question 22 is 4 marks)

TOTAL FOR PAPER IS 100 MARKS

22 The diagram shows a triangular prism *ABCDEF* with a horizontal base *ABEF*.

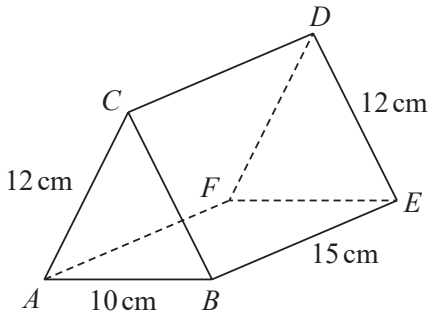


Diagram **NOT** accurately drawn

$AC = BC = FD = ED = 12\,\text{cm}$ $AB = 10\,\text{cm}$ $BE = 15\,\text{cm}$

Calculate the size of the angle between *AD* and the base *ABEF*.
Give your answer correct to 3 significant figures.

.....°

(Total for Question 22 is 4 marks)

18 The diagram shows a cube $ABCDEFGH$ with sides of length 6 cm.

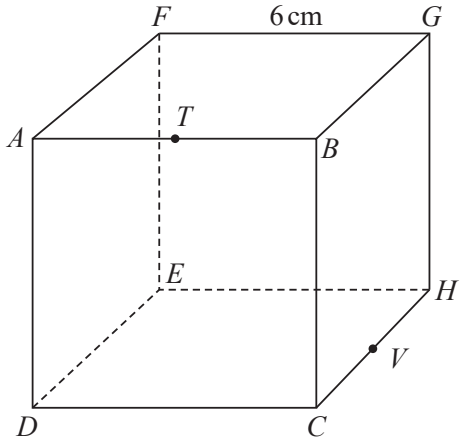


Diagram **NOT** accurately drawn

T is the midpoint of AB and V is the midpoint of CH

Work out the distance from T to V in a straight line through the cube.
Give your answer in the form $\sqrt{a}$ cm where a is an integer.

..... cm

(Total for Question 18 is 4 marks)

21 The diagram shows a triangular prism, *ABCDEF*, with a rectangular base *ABCD*

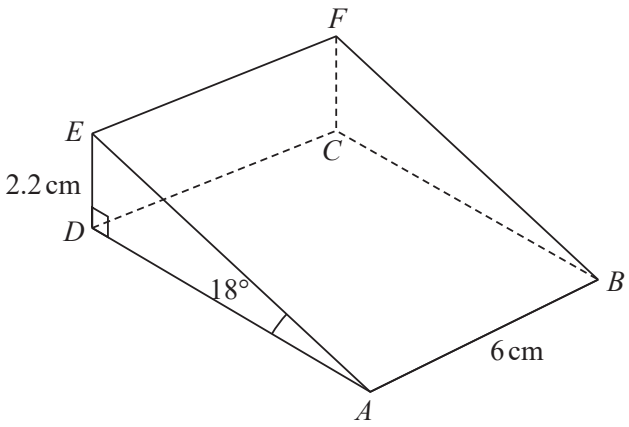


Diagram **NOT** accurately drawn

AB = 6 cm *DE* = 2.2 cm angle *DAE* = 18° angle *ADE* = 90°

Work out the angle that *BE* makes with the plane *ABCD*
Give your answer correct to one decimal place.

.....°

(Total for Question 21 is 4 marks)

24 The diagram shows a square-based pyramid $ABCDE$

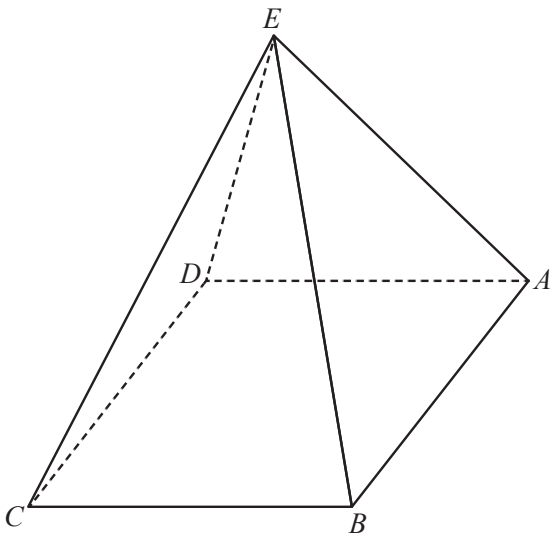


Diagram **NOT** accurately drawn

$EA = EB = EC = ED$

M is the centre of the horizontal square base $ABCD$
Q is the midpoint of AB
Angle $EQM = 80°$

$EA : AB = n : 1$

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

$n =$ .....

(Total for Question 24 is 4 marks)

Turn over for Question 25

18 The diagram shows cuboid *ABCDEFGH*.

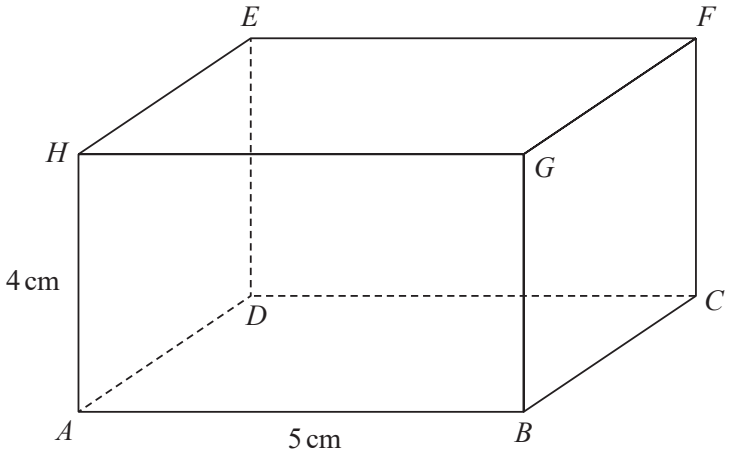


Diagram **NOT** accurately drawn

AB = 5 cm
AH = 4 cm
The size of the angle between *CH* and the plane *ABCD* is 35°

Calculate the volume of the cuboid.
Give your answer correct to 3 significant figures.

..... cm^3

(Total for Question 18 is 5 marks)

21 The diagram shows the prism $ABCDEFGHJK$ with horizontal base $AEFG$

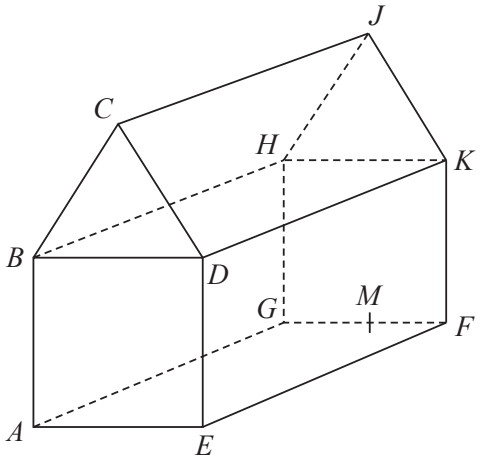


Diagram **NOT** accurately drawn

$ABCDE$ is a cross section of the prism where
$ABDE$ is a square
BCD is an equilateral triangle

$EF = 2 \times AE$
M is the midpoint of GF so that JM is vertical.

Angle $MAJ = y°$

Given that $\tan y° = T$

find the value of T, giving your answer in the form $\dfrac{\sqrt{p} + \sqrt{q}}{17}$ where p and q are integers.

$T =$ .....

(Total for Question 21 is 5 marks)

Turn over for Question 22

22 The diagram shows a triangle ABC and a flagpole BF

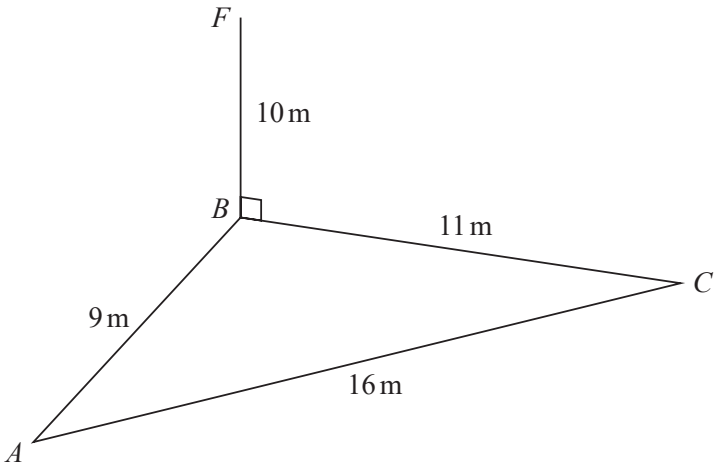


Diagram **NOT** accurately drawn

A, B and C are points on horizontal ground.

BF is vertical.

$AB = 9\,\text{m}$ $BC = 11\,\text{m}$ $AC = 16\,\text{m}$ $BF = 10\,\text{m}$

D is the point on AC such that angle $BDC = 90°$

Work out the size of the angle of elevation of the point F from the point D
Give your answer correct to one decimal place.

.....°

(Total for Question 22 is 5 marks)

Turn over for Question 23

22 Here is a cuboid $ABCDEFGH$

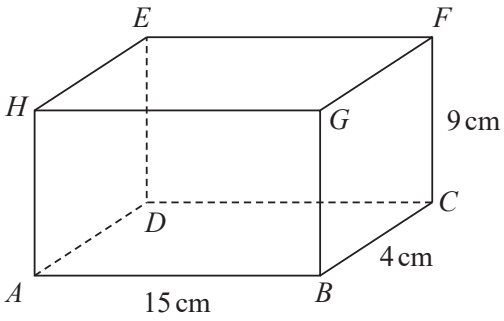


Diagram **NOT** accurately drawn

$AB = 15$ cm $BC = 4$ cm $CF = 9$ cm

(a) Work out the length of BE
Give your answer correct to 3 significant figures.

..... cm

(2)

Here is a cuboid *PQRSTUVW*

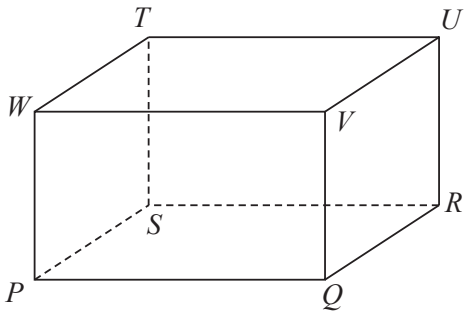


Diagram **NOT** accurately drawn

PR = 42 cm

The size of the angle between *PU* and the plane *PQRS* is 30°

M is the midpoint of *PR*

(b) Work out the size of angle *UMR*
Give your answer correct to 3 significant figures.

.....°

(3)

(Total for Question 22 is 5 marks)

23 The diagram shows a solid pyramid $ABCDE$ with a horizontal base.

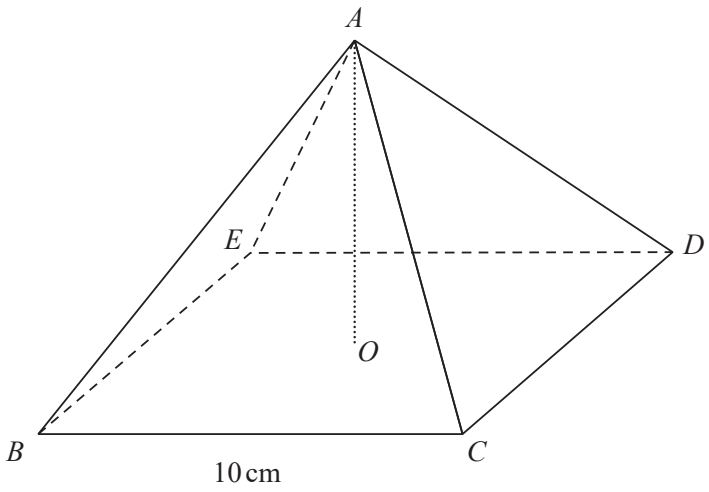


Diagram **NOT** accurately drawn

The base, $BCDE$, of the pyramid is a square of side 10 cm.

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

The **total** surface area of the pyramid is 360 cm^2

Work out the size of the angle between AC and the base $BCDE$.
Give your answer correct to 3 significant figures.

.....°

(Total for Question 23 is 6 marks)

Turn over for Question 24

17 The diagram shows a prism *ABCDEFGH* with a horizontal base.

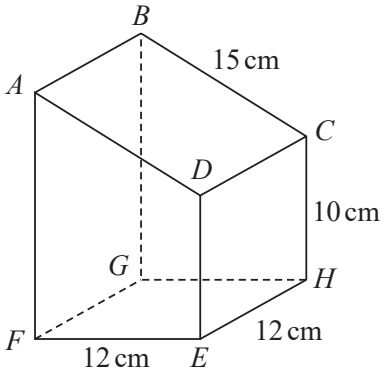


Diagram **NOT** accurately drawn

The base of the prism, *EFGH*, is a square of side 12 cm.
Trapezium *ADEF* is a cross section of the prism where *AF* and *DE* are vertical edges.

DE = *CH* = 10 cm
AD = *BC* = 15 cm

(a) Work out the size of the angle between *CF* and the base *EFGH*.
Give your answer correct to one decimal place.

..... °
(3)

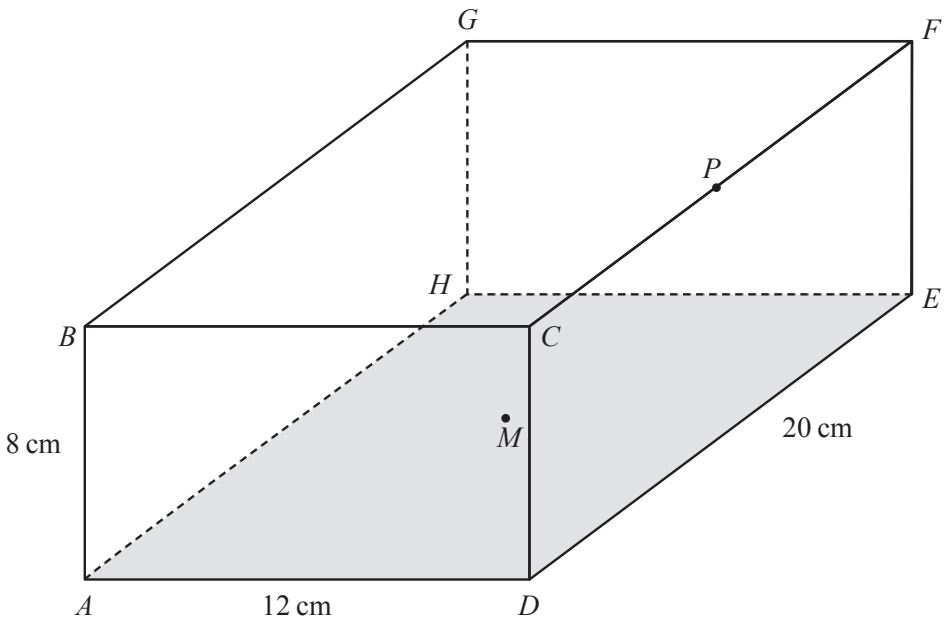
(b) Work out the length of *BE*.
Give your answer correct to one decimal place.

..... cm
(3)

(Total for Question 17 is 6 marks)

22 The diagram shows a cuboid *ABCDEFGH* with horizontal base *ADEH*

Diagram **NOT** accurately drawn



AB = 8 cm *AD* = 12 cm *DE* = 20 cm

M is the midpoint of the base *ADEH* and *P* is the midpoint of the edge *CF*

Work out the size of angle *BMP*
Give your answer correct to one decimal place.

.....°

(Total for Question 22 is 6 marks)

Turn over for Question 23

17 The diagram shows a solid prism *ABCDEFGH*.

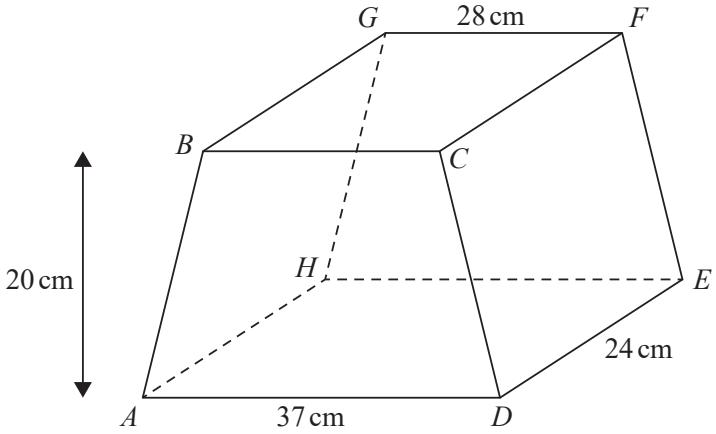


Diagram **NOT** accurately drawn

The trapezium *ABCD*, in which *AD* is parallel to *BC*, is a cross section of the prism.
The base *ADEH* of the prism is a horizontal plane.
ADEH and *BCFG* are rectangles.
The midpoint of *BC* is vertically above the midpoint of *AD* so that *BA* = *CD*.

AD = 37 cm *GF* = 28 cm *DE* = 24 cm

The perpendicular distance between edges *AD* and *BC* is 20 cm.

(a) Work out the total surface area of the prism.

..... cm²

(4)

(b) Calculate the size of the angle between AF and the plane $ADEH$.
Give your answer correct to one decimal place.

.....°

(3)

(Total for Question 17 is 7 marks)

MARK SCHEMES

official mark schemes, in the same order as the questions

Question		Working	Answer	Mark	Notes
7	(a)		$5y^4$	2	B2 B1 for fully simplifying terms in x or terms in y
	(b)	$h - f = 3e$ or $\frac{h}{3} = e + \frac{f}{3}$ or $\frac{h-f}{3}$	$e = \frac{h-f}{3}$	2	M1
					A1 oe, accept $e = \frac{f-h}{-3}$
					Total 4 marks

8	$160^2 + 200^2$ (=65600)		3	M1
	$\sqrt{160^2 + 200^2}$			M1
		256		A1 accept 256 – 256.2
				Total 3 marks

9	Interior angle of pentagon (180 × 3) ÷ 5 (= 108) oe		4	M1 or exterior angle of pentagon = $\frac{360}{5}$ (= 72)
	Interior angle of octagon (180 × 6) ÷ 8 (= 135) oe			M1 or exterior angle of octagon = $\frac{360}{8}$ (= 45)
	(*CBF* =) 360 – ("108" + "135") (= 117)			M1 (*CBF* =) "72" + "45" (= 117)
		31.5		A1
				Total 4 marks

8			Trapezium with vertices at (6, 3) (8, 3) (8, 6) (4, 6)	2	B2 If not B2 then award B1 for shape of correct size and orientation **or** 3 or 4 points plotted correctly	
						Total 2 marks

9		$\cos 63 = \frac{24.3}{(PQ)}$ **or** $\sin 27 = \frac{24.3}{(PQ)}$ **or** $\frac{(PQ)}{\sin 90} = \frac{24.3}{\sin 27}$ **or** $\frac{\sin 90}{(PQ)} = \frac{\sin 27}{24.3}$ oe		3	M1 for a correct trigonometric ratio	M2 for $(RQ =) 24.3 \times \tan 63 (= 47.6914..)$ **and** $(PQ =) \sqrt{47.6914^2 + 24.3^2}$ oe
		$(PQ =) \frac{24.3}{\cos 63}$ **or** $(PQ =) \frac{24.3}{\sin 27}$ **or** $(PQ) = \frac{24.3}{\sin 27} \times \sin 90$			M1 for a correct rearrangement for PQ	
			53.5		A1 Accept 53.5 - 53.53	
						Total 3 marks

Question	Working	Answer	Mark	Notes
4	$8.5^2 + 5.6^2$ (= 103.61)		3	M1
	$\sqrt{8.5^2 + 5.6^2}$			M1
		10.2		A1 Accept 10.1 to 10.2 or better
				Total 3 marks

5	3 hours 36 mins = 216 (mins) or 3.6 (hours) or $3\frac{36}{60}$ oe (hours)		3	M1
	2470 ÷ 3.6 or 2470 ÷ $3\frac{36}{60}$ or 2470 ÷ 216 × 60			M1 Allow 2470 ÷ 3.36 (=735 or better)
		686		A1 Accept 686.1 or better
				Total 3 marks

6		Fully correct perpendicular bisector with all relevant arcs shown.	2	B2 Fully correct bisector with all arcs. Correct arcs can be on the same side of *AB*. B1 for all correct arcs and no bisector drawn or for a correct bisector within guidelines but no arcs. NB: On tramlines = within tramlines.
				Total 2 marks

7	(adding) $10x = -5$ or $21x + 35y = 42$ $21x - 15y = -33$ then $50y = 75$		3	M1 Correct method to eliminate x or y Or making coefficients of x or y the same **and** correct operator has been applied to eliminate x or y (2 out of 3 terms correct implies a correct operator) or correct algebraic substitution for x or y into other equation
		$x = -0.5$ oe $y = 1.5$ oe		A1 Both A marks dep on M1 A1
				Total 3 marks

International GCSE Maths

Apart from Questions 6, 7, 13, and 18 (where the mark scheme states otherwise), the correct answer, unless clearly obtained by an incorrect method, should be taken to imply a correct method.

Q	Working	Answer	Mark	Notes
1 (a)		e^6	1	B1 cao
(b)	$x^2 - 3x + x - 3$		2	M1 for any 3 correct terms **or** for 4 out of 4 correct terms ignoring signs **or** for $x^2 - 2x \ldots$ **or** for $\ldots -2x - 3$
	Correct answer scores full marks (unless from obvious incorrect working)	$x^2 - 2x - 3$		A1
				Total 3 marks

2	$30^2 + h^2 = 52^2$ oe or $900 + h^2 = 2704$ $(h^2 =) 52^2 - 30^2 (= 1804)$ or $(h^2 =) 2704 - 900 (= 1804)$		3	M1 for applying Pythagoras theorem correctly
	$(h =) \sqrt{52^2 - 30^2}$ $(= \sqrt{1804})$ (= 42.47352..) or $(h =) \sqrt{2704 - 900}$ $(= \sqrt{1804})$ (= 42.47352..)			M1 for square rooting
	Correct answer scores full marks (unless from obvious incorrect working)	42.5		A1 awrt 42.5 or allow $2\sqrt{451}$
				Total 3 marks

20	eg $(AC^2 =)18^2 - 7^2 (= 275)$ **or** $(AC =)\sqrt{18^2 - 7^2} (= \sqrt{275}$ or $5\sqrt{11}$ or $16.5(831...))$ **or** $(FB^2 =)9^2 + 7^2 (= 130)$ **or** $(FB =)\sqrt{9^2 + 7^2} (= \sqrt{130}$ or $11.4(017...))$ **or** $(GC^2 =)18^2 - 9^2 (= 243)$ **or** $(GC =)\sqrt{18^2 - 9^2} (= \sqrt{243}$ or $9\sqrt{3}$ or $15.5(884...))$ **or** $18^2 = (BC)^2 + 7^2 + 9^2$ oe		3	M1	for method to find AC^2 **or** AC **or** FB^2 **or** FB **or** GC^2 **or** GC **or** for a correct equation using BC^2 and 18 and 7 and 9 other longer ways to find AC, FB, GC may be used but must be a complete method eg $\angle FCA = \sin^{-1}\left(\frac{7}{18}\right) (= 22.88...)$ **and** $AC = \frac{7}{\tan"22.88..."}$
	eg $"275" - 9^2 (= 194)$ **or** $"16.5..."^2 - 9^2 (= 194)$ **or** $18^2 - "130" (= 194)$ **or** $18^2 - "11.4..."^2 (= 194)$ $"243" - 7^2 (= 194)$ **or** $"15.5..."^2 - 7^2 (= 194)$ **or** $18^2 - 7^2 - 9^2 (= 194)$ **or** $\angle FCB = \sin^{-1}\left(\frac{"11.4"}{18}\right) (= 39.3(036...))$ **and** $\cos"39.3" = \frac{(BC)}{18}$ or $\tan"39.3" = \frac{"11.4"}{(BC)}$ oe			M1	for complete method to find BC^2 other longer ways to find BC may be used but must be a complete method, leading to a trig equation in BC
	Correct answer scores full marks (unless from obvious incorrect working)	13.9		A1	accept 13.8 to 14
					Total 3 marks

Question	Working	Answer	Mark	Notes
8	$\frac{1}{2}\times 5\times h = 12$ oe **or** $\frac{1}{2}\times 2.5\times h = 6$ oe **or** $h = 4.8$			M1 NB: 4.8 may be seen on the diagram
	$(x =)\sqrt{2.5^2 + "4.8^2"}$ **or** $(x =)\sqrt{"29.29"}$ **or** 5.41(202…)			M1 ft the candidate's value for height for this mark (award of this mark does **not** depend on award of previous mark)
	$2\times "5.41" + 5$			M1 dep on previous M1
		15.8	4	A1 for 15.8 – 15.83

Question	Working	Answer	Mark	Notes
2	$\frac{3}{4}\times 60$ (= 45) **or** $\frac{1}{4}\times 60 (=15)$ **OR** $\frac{3}{4}\times\frac{3}{5}\left(=\frac{9}{20}\right)$ $\frac{3}{5}\times$"45" (= 27) **or** $\frac{4}{5}\times$"15" (= 12) **OR** $\frac{1}{4}\times\frac{4}{5}\left(=\frac{4}{20}\right)$ $\frac{\text{"27"+"12"}}{60}$ **OR** "$\frac{9}{20}$"+"$\frac{4}{20}$"	$\frac{13}{20}$	4	M1 M1 M1 For a complete method A1 oe
3	$14^2 - 10^2$ (= 96) "96"+ 5^2 (= 121) $\sqrt{\text{"121"}}$	11	4	M1 M1 M1 A1
4	(a =) 40 − 14 (=26) e.g. $\frac{\text{"26"}+b}{2}=30$ **or** 30 + (30 – "26")	26 34	3	M1 Method to find a M1 Method to find b A1

6 (a)	4.25 × 0.08 (= 0.34) oe		3	M1	M2 for 4.25 × 1.08 oe
	4.25 + "0.34"			M1	
		4.59		A1	SC: B1 for 4.25 × 0.92 (= 3.91) oe
(b)	9.45 ÷ 108 (= 0.0875) oe		3	M1	M2 for 9.45 ÷ 1.08
	9.45 ÷ 108 × 100 oe			M1	
		8.75		A1	
					Total 6 marks

7	$7.5^2 - 6^2$ (= 20.25)		4	M1	**OR** for a correct trig statement involving one of the angles e.g. $\cos BAM = \frac{6}{7.5}$ **or** $\sin ABC = \frac{6}{7.5}$ where *M* is the midpoint of *BC*
	$\sqrt{7.5^2 - 6^2}$ (= 4.5)			M1	**OR** for a method to find one of the angles in the triangle e.g. $BAM = \cos^{-1}\left(\frac{6}{7.5}\right)(= 36.8...)$ **or** $ABC = \sin^{-1}\left(\frac{6}{7.5}\right)(= 53.1...)$
	"4.5"× 6 oe			M1	for a complete method to find the area of triangle *ABC* e.g. $2 \times \frac{1}{2} \times 7.5 \times 6 \times \sin("36.8")$ oe **or** $2 \times \frac{1}{2} \times 7.5 \times \sqrt{7.5^2 - 6^2} \times \sin("53.1")$ oe
		27		A1	cao
					Total 4 marks

6				M1 for $y = 3x + c$ oe **or** $y = mx - 2$ oe **or** $3x - 2$ **or** eg $L = 3x - 2$ **or** $y = 3(x \pm a)$
		$y = 3x - 2$	2	A1 oe eg $y - 4 = 3(x - 2)$ $y - 1 = 3(x - 1)$ $y - a = 3(x - b)$ where (a, b) is any coordinate on the line
				Total 2 marks

7	$\tan x = \frac{3.4}{4.7}$ oe eg $\cos x = \frac{4.7}{\sqrt{3.4^2 + 4.7^2}}$ oe			M1 or $\sin x = \frac{3.4\sin 90}{\sqrt{3.4^2 + 4.7^2}}$ oe
	$(x =) \tan^{-1}\left(\frac{3.4}{4.7}\right)$ oe eg $(x =) \cos^{-1}\left(\frac{4.7}{\sqrt{3.4^2 + 4.7^2}}\right)$			M1 or $(x =) \sin^{-1}\left(\frac{3.4\sin 90}{\sqrt{3.4^2 + 4.7^2}}\right)$ oe
		35.9	3	A1 accept 35.7 - 36.1
				Total 3 marks

8	$8.5^2 - (8 \div 2)^2$ (= 56.25) **or** $\cos x = \frac{4}{8.5}$ oe			M1 **or** eg $\cos A = \frac{8^2 + 8.5^2 - 8.5^2}{2 \times 8 \times 8.5}$
	$\sqrt{"56.25"}$ (= 7.5) **or** $x = \cos^{-1}\left(\frac{4}{8.5}\right)$ (= 61.927...) oe			M1 **or** eg $(A =) \cos^{-1}\left(\frac{8^2 + 8.5^2 - 8.5^2}{2 \times 8 \times 8.5}\right)$ (61.927...) (other angle = 56.144...)
	8 × "7.5" ÷ 2 oe **or** 0.5 × 8 × 8.5 × sin "61.927..."			M1 **or** eg 0.5 × 8.5 × 8 × sin"61.927..." oe
		30	4	A1
				Total 4 marks

7	$4.3^2 + 6.4^2$ or 59.45		4	M1	for squaring and adding
	$\sqrt{4.3^2 + 6.4^2}$ or $\sqrt{59.45}$ or 7.71(038…) or 7.7			M1	dep 1st M1 for square rooting
	e.g ('7.71' + 4.3 + 6.4) × 22 or '18.4' × 22 (=404.8) or ('8' + 4.3 + 6.4) × 22 or '18.7' × 22 or '19' × 22 or '20' × 22			M1	dep M2 for a non-rounded perimeter × 22 or 19 × 22 accept 20 × 22 oe
		$418		A1	cao
					Total 4 marks

8	15 × 24 (= 360) **or** 25 × 18 (= 450)		3	M1	may be implied by 810 seen
	$\frac{'360'+'450'}{40}$ $(=\frac{810}{40})$			M1	dep on M1
		20.25 oe		A1	for 20.25 accept 20.3 (allow 20 from correct working)
					Total 3 marks

8	$12.6 \times 10^{(-24+145)}$ or 12.6×10^{121} or 1.26×10^{n}		2	M1
		1.26×10^{122}		A1 allow 1.3×10^{122}
				Total 2 marks

9	$17.5^2 - 14^2$ (= 110.25)		4	M1	or for use of cosine rule to find one of the angles eg $28^2 = 17.5^2 + 17.5^2 - 2 \times 17.5 \times 17.5 \times \cos A$ **or** eg $\cos B = \frac{14}{17.5}$
	$\sqrt{17.5^2 - 14^2}$ (=10.5)			M1	**or** for rearranging the cosine rule to eg $\cos A = \frac{17.5^2 + 17.5^2 - 28^2}{2 \times 17.5 \times 17.5}$ (A = 106.26...) **or** eg $B = \cos^{-1}(\frac{14}{17.5})$ (= 36.86...)
	0.5 × 28 × "10.5" oe			M1	**or** for 0.5 × 17.5 × 17.5 × sin106.26... oe eg 0.5 × 17.5 × 28 × sin36.86... [clear use of Heron's formula: M1 for S = 0.5(17.5 + 17.5 + 28)(=31.5) M2 for $\sqrt{"31.5"("31.5"-17.5)^2("31.5"-28)}$ oe]
		147		A1	accept awrt 147
					Total 4 marks

3	$12.8^2 + x^2 = 16^2$ oe or $163.84 + x^2 = 256$ or $(x^2 =) 16^2 - 12.8^2$ $(= 92.16)$ or $(x^2 =) 256 - 163.84$ $(= 92.16)$		4	M1 for applying Pythagoras theorem correctly Allow $\cos^{-1}\left(\frac{12.8}{16}\right)(= 36.9...)$ **and** $\frac{x}{\sin(36.9...)} = \frac{16}{(\sin 90)}$
	$(x =) \sqrt{16^2 - 12.8^2}$ $(= \sqrt{92.16})$ $(= 9.6)$ or $(x =) \sqrt{256 - 163.84}$ $(= \sqrt{92.16})$ $(= 9.6)$			M1 for square rooting Allow $x = \frac{16}{(\sin 90)} \times \sin(36.9...)$
	(12.8 – "9.6") + "9.6" + "9.6" + 16 + 16 + 16 oe			M1 (dep on M1) for a complete method to find the perimeter
		70.4		A1 oe e.g. $\frac{352}{5}$
				Total 4 marks

4	(a)		15, 0, −1, 3	2	B2 for 4 correct values (B1 for 2 or 3 correct values)
	(b)	(−2, 15) (−1, 8) (0, 3) (2, −1) (3, 0) (4, 3)		2	M1 (dep on B1) ft from (a) for at least 5 points plotted correctly
			correct graph		A1 for a correct graph (clear intention to go through all the points and which must be curved at the bottom) **Note**: If a fully correct graph is shown, but an incomplete table is shown in (a), then award the marks for (a)
					Total 4 marks

5	$7.2^2 + 5.4^2$ (= 81)		4	M1	for correct first step using Pythagoras	M1 for reaching one step from the length of *AB* if using trig eg $(EAB =) \tan^{-1}\left(\frac{5.4}{7.2}\right) (= 36.8...)$ **and** $\sin("36.8...") = \frac{5.4}{AB}$
	$\sqrt{7.2^2 + 5.4^2}$ (= 9)			M1	for complete Pythagoras method to find length of *AB*/*DC* check the diagram for sight of 9, *DC* marked as 9 implies M2	M1 for complete method to find the length of *AB*/*DC* eg $\frac{5.4}{\sin("36.8...")} (= 9)$
	7.2 + 5.4 + 6 + "9" + 6 oe			M1	for a complete method to find the perimeter	
	Correct answer scores full marks (unless from obvious incorrect working)	33.6		A1	oe	
						Total 4 marks

7	(a)(i)		23, 24 ,27, 29, 30, 31, 33	1	B1 in any order with no repeats
	(a)(ii)		27, 33	1	B1 in any order with no repeats
	(b)	eg 1. Yes, no members/numbers/values in common 2. Yes, nothing in common 3. Yes, no common members/numbers/values 4. Yes, they share no common members/numbers/values 5. Yes, there is not the same members/numbers/values in both sets 6. Yes, there is no intersection or there is nothing in B and C 7. Yes, as there are no members/numbers/values the same (in B and C) 8. Yes, no members/numbers/values in B are in C or vice versa 9. Yes, there are no members/numbers in B that are multiples of 3 10. Yes, there are no members/numbers/values in that empty set 11. Yes, 23, 29, 31 not in C 12. Yes, 24, 27, 30, 33 are not in B Allow sector for set This is not an exhaustive list Allow element(s) for members/numbers/values	Yes, there are no multiples of 3 in set *B*	1	B1 for Yes and a statement which indicates correct meanings of intersection and empty set. If no box is ticked, then the 'Yes' must be stated in the answer
	(c)		23, 25, 29, 31	2	B2 for the four correct numbers and no additions (B1 for three correct values with no more than one incorrect or for four correct values with no more than one incorrect)
					Total 5 marks

Question	Working	Answer	Mark	Notes
10	(54 – 24) ÷ 2 (=15) [may be marked on diagram]		5	M1
	"15"^{2} – (24 ÷ 2)^2 (= 81)			M1 ft their "15" (if > 12)
	[height =] $\sqrt{\text{"15"}^2-(24\div 2)^2}$ (= 9)			M1 ft their "15" (if > 12)
	(24 × "9") ÷ 2 oe			M1 figures must be from correct working
	Correct answer scores full marks (unless from obvious incorrect working)	108		A1 allow 107.9 – 108.1
	ALTERNATIVES BELOW			**Total 5 marks**
10	(54 – 24) ÷ 2 (=15) [may be marked on diagram]		5	M1
	or $x=\cos^{-1}\left(\frac{\text{"12"}}{\text{"15"}}\right)(=36.86...)$ **or** $y=\sin^{-1}\left(\frac{24\div 2}{\text{"15"}}\right)(=53.13...)$ **or** $A=\cos^{-1}\left(\frac{15^2+15^2-24^2}{2\times 15\times 15}\right)(=106.2...)$ **or** $B=\cos^{-1}\left(\frac{15^2+24^2-15^2}{2\times 15\times 24}\right)(=36.8....)$			M1 ft their "15" (if > 12) [using Hero's formula S = 0.5 × 54 (= 27) and] 27 × (27 – 24) × (27 – "15") × (27 – "15")
	or "12"tan"36.86…" (= 9) (allow 8.9… for these) "12" ÷ tan"53.13…" (= 9) **or** "15" × sin "36.86…" (= 9) **or** "15" × cos "53.13…" (= 9)			M1 ft their "15" (if > 12) — M2 for 0.5 × 24 × "15" × sin"36.86…" or 0.5 × "15" × "15" × sin(2 × "53.13…") or 0.5×"15"×"15"×sin("106.2...") **or** $\sqrt{\text{"27"}(\text{"27"}-24)(\text{"27"}-\text{"15"})(\text{"27"}-\text{"15"})}$
	(24 × "9") ÷ 2 oe			M1
	Correct answer scores full marks (unless from obvious incorrect working)	108		A1 allow 107.9 – 108.1
				Total 5 marks

Q	Working	Answer	Mark	Notes
10	$(AC^2 =)12^2+16^2\ (=144+256=400)$ **or** $(BAC =)\tan^{-1}\left(\frac{12}{16}\right)(=36.8(698...))$ **or** 36.9 **or** $(BCA =)\tan^{-1}\left(\frac{16}{12}\right)(=53.1(301...))$		5	M1 for a correct method using triangle *ABC*
	$(AC =)\sqrt{12^2+16^2}\ (=\sqrt{144+256}=\sqrt{400}=20)$ **or** $(AC =)\frac{16}{\cos"36.8"}(=20)$ **or** $(AC =)\frac{12}{\sin"36.8"}(=20)$ **or** $(AC =)\frac{16}{\sin"53.1"}(=20)$ **or** $(AC =)\frac{12}{\cos"53.1"}(=20)$			M1 for a correct method to find *AC*
	$(BD^2 =)(1.5\times"20")^2-16^2(=644)$ **or** $(BD^2 =)30^2-16^2\ (=900-256=644)$ **or** $(BAD =)\cos^{-1}\left(\frac{16}{"30"}\right)(=57.7(690...))$ **or** 57.8 **or** $(BDA =)\sin^{-1}\left(\frac{16}{"30"}\right)(=32.2(309...))$ **or** $(BCA =)\sin^{-1}\left(\frac{16}{"20"}\right)(=53.1(301...))$ **and** $\frac{(CD)}{\sin(180-126.9-32.2)}=\frac{"30"}{\sin(180-53.1)}$ oe			M1 for a correct method using triangle to find BD^2 or angle *BAD* or angle *BDA* or for a correct equation for side *CD*
	$(BD =)\sqrt{(1.5\times"20")^2-16^2}\ (=25.3(771)\ldots)$ **or** $(BD =)\sqrt{30^2-16^2}\ (=\sqrt{900-256}=\sqrt{644}=2\sqrt{161}=25.3(771...))$ **or** $(BD =)16\times\tan"57.7"(=25.3(771...))$ **or** $(BD =)"30"\times\sin"57.7"(=25.3(771...))$ **or** $(BD =)\sqrt{16^2+"30"^2-2\times16\times"30"\times\cos"57.7"}(=25.3(771...))$ **or** $(BD =)30\times\cos"32.2"(=25.3(771...))$ **or** $(BD =)\frac{16}{\tan"32.2"}(=25.3(771...))$ **or** $(BD =)\frac{16}{\sin"32.2"}\times\sin"57.7"(=25.3(771...))$ **or** $(CD =)\frac{"30"}{\sin"126.9"}\times\sin"20.9"$ oe			M1 for a correct method to find *BD* or *CD*
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	13.4		A1 awrt 13.4
				Total 5 marks

11	$(AD^2 =)\ 28^2 + 45^2\ (= 784 + 2025 = 2809)$ **or** $(EDA =)\ \tan^{-1}\left(\frac{28}{45}\right)\ (= 31.8(9...))$ **or** $(EAD =)\ \tan^{-1}\left(\frac{45}{28}\right)\ (= 58.1(09...))$		5	M1 for a correct method to find AD^2 **or** angle *EDA* **or** angle *EAD*
	eg $(AD =)\ \sqrt{28^2 + 45^2}\ (= \sqrt{784 + 2025} = \sqrt{2809} = 53)$ oe **or** $(AD =)\ \frac{28}{\sin 31.8(9...)}\ (= 53...)$ **or** $(AD =)\ \frac{45}{\cos 31.8(9...)}\ (= 53...)$ oe **or** $(AD =)\ \frac{45}{\sin 58.1...}\ (= 53...)$ **or** $(AD =)\ \frac{28}{\cos 58.1...}\ (= 53...)$ oe			M1 for a correct method to find *AD*
	eg $(BC =)\ \sqrt{35^2 - ("53" - 21)^2}\ (= \sqrt{1225 - 1024} = \sqrt{201} = 14.1(7...))$ **or** $(BDC =)\ \cos^{-1}\left(\frac{"53" - 21}{35}\right)\ (= 23.8(9...))$ **or** $(BCD =)\ \sin^{-1}\left(\frac{"53" - 21}{35}\right)\ (= 66.1...)$			M1 for correct method to find *BC* **or** angle *BDC* **or** angle *BCD*
	eg $\frac{1}{2} \times$ "14.1(7...)" $\times$ ("53" - 21) $(= 16\sqrt{201})$ **or** $\frac{1}{2} \times 35 \times$ ("53" - 21) $\times \sin$("23.8(9...)") **or** $\frac{1}{2} \times 35 \times$ "14.1(7...)" $\times \sin$("66.1...")			M1 for a correct method to find the area of triangle *CDB*
	Correct answer scores full marks (unless from obvious incorrect working)	227		A1 awrt 227 accept $16\sqrt{201}$
				Total 5 marks

11	$(AX =)\ (17.6 - 8.4) \div 2\ (= 4.6)$		6	M1 where X is the foot of the perpendicular from B to AD
	$0.5 \times (8.4 + 17.6) \times h = 179.4$ **or** $0.5 \times$ '4.6' $\times h + 0.5 \times$ '4.6' $\times h + 8.4 \times h = 179.4$ **or** $13 \times h = 179.4$			M1
	$(h =)\ 179.4 \div$ '13' (=13.8) **or** $(h =)\ 358.8 \div$ '26' (=13.8) oe			M1
	$\tan ABX = \frac{'4.6'}{'13.8'}$ **or** $\tan BAX = \frac{'13.8'}{'4.6'}$			M1 ft their h dep on second M1 $(AB =)\sqrt{'4.6'^2 + '13.8'^2} = \sqrt{211.6}$ = (14.546…) **and** one from $\sin ABX = \frac{'4.6'}{'\sqrt{211.6}'}$ or $\sin BAX = \frac{'13.8'}{'\sqrt{211.6}'}$ or $\cos ABX = \frac{'13.8'}{'\sqrt{211.6}'}$ or $\cos BAX = \frac{'4.6'}{'\sqrt{211.6}'}$ or $\sin ABX = \frac{'4.6' \times \sin 90}{'\sqrt{211.6}'}$ or $\cos ABX = \frac{'\sqrt{211.6}' + '13.8'^2 - '4.6'^2}{2 \times '\sqrt{211.6}' \times '13.8'}$
	$(ABX =)\ \tan^{-1}\left(\frac{'4.6'}{'13.8'}\right)\ (= 18.4)$ **or** $(BAX =)\ \tan^{-1}\left(\frac{'13.8'}{'4.6'}\right)\ (= 71.6)$			M1
		108.4		A1 awrt 108.4
				Total 6 marks

11	$(AB^2 =)\ 7.5^2 - 6^2\ (=\ 20.25)$ **or** eg $(BAC =)\sin^{-1}\left(\frac{6}{7.5}\right)(=53.1...)$ **or** $\cos(BCA) = \frac{6}{7.5}(=0.8)$		6	M1	for a correct first step to find *AB* **or** a complete method to find angle *BAC* **or** a correct first step to find angle *BCA*
	$(AB =)\ \sqrt{7.5^2 - 6^2}\ (=4.5)$ **or** $(AB =)\frac{6}{\tan"53.1"}(=4.5...)$ **or** $(AB =)7.5\cos"53.1"(=4.5...)$ **or** $(BCA =)\cos^{-1}\left(\frac{6}{7.5}\right)(=36.8...)$			M1	for a complete method to find *AB* **or** angle *BCA*
	(Area *ABC* =) $\frac{1}{2}\times 6\times"4.5"$ (= 13.5) **or** $(\text{Area } ABC =)\frac{1}{2}\times 6\times 7.5\times\sin("36.8")(=13.47...\text{ or } 13.5)$			M1	ft [their labelled *AB*] or [their labelled *BCA*] eg for $\frac{1}{2}\times 6\times$[their labelled *AB*] **or** $\frac{1}{2}\times 6\times 7.5\times\sin$[their labelled *BCA*]
	(Area *DAC* =) 31.5 – "13.5" (= 18) **or** "13.5" + 0.5 × 7.5 × *AD* = 31.5 oe			M1	ft (dep on previous M1) allow 31.5 – [their area]
	(*AD* =) ("18" ÷ 7.5) ÷ 0.5 oe			M1	for a complete method to find *AD*, dependent on correct working
		4.8		A1	accept 4.78 – 4.81
					Total 6 marks

12	(a)		$3^2\times 5\times 7$	1	B1	accept 3 × 3 × 5 × 7 oe or 315
	(b)		$3^{11}\times 5^7\times 7^5$	2	B2	fully correct answer (allow *x* = 11, *y* = 7, *z* = 5) (B1 for an answer in the form $3^p\times 5^q\times 7^r$ where one or two of *p*, *q* or *r* are correct)
						Total 3 marks

8	$\frac{14+AB}{2}\times 15 = 360$ oe **or** $360-14\times 15 (=150)$ oe		6	M1	for setting up an equation using the area of the trapezium **or** method to find the area of the triangle
	$AB = 34$ **or** $MB = 20$ (where M is point on AB such that MC is perpendicular to AB)			A1	could be seen on diagram
	$(CB^2 =) 15^2 + 20^2 (= 625)$ **or** $(CB^2 =) 15^2 + MB^2$			M1	allow use of their MB
	$(CB =) \sqrt{15^2 + 20^2} (= 25)$ **or** $(CB =) \sqrt{15^2 + MB^2}$			M1	allow use of their MB
	14 + 15 + "34" + "25" oe **or** 14 + 15 + 14 + MB + CB oe			M1ft	(dep on previous two M marks) for a method to find the perimeter of the trapezium, allow use of their MB and CB
	Correct answer scores full marks (unless from obvious incorrect working)	88		A1	cao
					Total 6 marks

Question	Working	Answer	Mark	Notes
8	$\cos 52 = \frac{12.6}{x}$ **or** sin 38 = $\frac{12.6}{x}$		3	M1 Or use of tan to find horizontal side 12.6 × tan 52 or $\frac{12.6}{\tan 38}$ (=16.12…) **and** a correct first stage to find x eg $x^2 = 12.6^2 + \text{“16.12…”}^2$ or $\sin 52 = \frac{\text{"16.12..."}}{x}$ oe Allow correct first stage of sine rule
	$(x =)\frac{12.6}{\cos 52}$ **or** $\frac{12.6}{\sin 38}$ $(= \frac{12.6}{0.61566...})$ **or**			M1 Accept decimal correct to at least 3SF Or $(x =)\sqrt{12.6^2 + \text{"16.12..."}^2}$ **or** $(x =) \frac{\text{"16.12..."}}{\sin 52}$ Allow fully rearranged sine rule
		20.5		A1 20.4 – 20.5
				Total 3 marks

13	$\sin 23° = \frac{"h"}{500}$ oe or $\cos 67° = \frac{"h"}{500}$ oe or $\frac{"h"}{\sin 23°} = \frac{500}{\sin 90°}$ or $\frac{\sin 23}{"h"} = \frac{\sin 90}{500}$ oe **or** $\cos 23° = \frac{"x"}{500}$ oe or $"x" = 500\cos 23°$ (= 460.25..) **and** $"h"^2 = 500^2 - ("460.25..."")^2$ oe		3	M1 for a correct expression involving "h"
	"h" = 500 × sin 23° oe **or** $"h" = \sqrt{500^2 - ("460.25..."")^2}$			M1
		195. 4		A1 195 – 195.4
				Total 3 marks

Question	Working	Answer	Mark	Notes
7	$\sin 42 = \frac{6.5}{x}$ **or** $\frac{x}{\sin 90} = \frac{6.5}{\sin 42}$ or $\cos 48 = \frac{6.5}{x}$ [where 48 = 180 – 90 – 42]		3	M1 **or** use of tan to find the horizontal side **and** then a correct first step in Pythagoras' theorem ie [base =] $\frac{6.5}{\tan 42}$ (= 7.21...) and [x^2 =] 6.5^2 + "7.21…"^{2}
	[x =] $\frac{6.5}{\sin 42}$ **or** $\frac{6.5\sin 90}{\sin 42}$ **or** [x =] $\frac{6.5}{\cos 48}$ [where 48 = 180 – 90 – 42]			M1 **or** complete method using Pythagoras [x =] $\sqrt{6.5^2 + "7.21..."^2}$ (If students give this statement with nothing before it they gain M2)
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	9.7		A1 accept 9.7 – 9.72
				Total 3 marks

3	eg $\sin 65 = \frac{AB}{8.4}$ **or** $\frac{AB}{\sin 65} = \frac{8.4}{\sin 90}$		3	M1	for setting up a trig equation in AB
	eg $(AB =)\ 8.4\sin 65$ **or** $(AB =)\frac{8.4\sin 65}{\sin 90}$			M1	for a complete method
		7.61		A1	accept 7.61 – 7.613
					Total 3 marks

4	eg $\frac{2}{5} \times 150 (= 60)$ **or** eg $0.32 \times 150\ (= 48)$		5	M1	for finding the number of small mugs **or** number of medium mugs
	eg $150 - \text{“60”} - \text{“48”}\ (= 42)$			M1	for finding the number of large mugs
	eg “60” × 8.50 + “48”× 11.20 + “42” × 14.20(= 1644) **or** 510 + 537.6 + 596.4 (= 1644)			M1	for working out the income, Profit = 504 implies M3
	eg $\frac{\text{"1644"} - 1140}{1140} \times 100$ **or** $\frac{\text{"1644"}}{1140} \times 100 - 100$			M1	(indep) for a complete method to find the percentage profit for **their total income** (must be greater than 1140) An answer of 144 implies M4
		44		A1	44 or better (44.2105…)
					Total 5 marks

12	216 or 2.16 or 10^{120} or 10^{122} or $6^3 \times 10^{40\times3}$		3	M1 or for digits 216
	216×10^{120} oe or or 2.16×10^n where $n \neq 122$			M1
		2.16×10^{122}		A1
				Total 3 marks

13		$x \geq -1$	1	B1 oe condone > in place of ≥
		$y \geq x$	1	B1 oe condone > in place of ≥
		$x + 2y \leq 8$	1	B1 oe condone < in place of ≤
				SCB1 if all inequalities reversed
				Total 3 marks

14	$12 \times \tan 5$ (=1.05) **or** $\tan 5 = \frac{'y'}{12}$ **or** $12\tan5$ **or** $\tan 85 = \frac{12}{'y'}$ **or** $\frac{12}{\tan 85}$ $\frac{y}{\sin 5} = \frac{12}{\sin 85}$ oe **or** (y =) 1.04986… oe		3	M1 oe correct expression using tan or the sine rule or $\sqrt{\left(\frac{12}{\cos 5}\right)^2 - 12^2}$ (= 1.04986…)
	(AB =) 2.6 + "1.05" oe			M1
		3.65		A1 allow awrt 3.65
				Total 3 marks

15	5 5 7 8 10 12 13 14 16 21 23		3	M1 For ordering the numbers Allow one error or omission in the list.
	16 & 7 identified for LQ and UQ			M1 For identifying 16 and 7 – may also have identified the median (12)
		9		A1
				Total 3 marks

12	$\tan'x' = \frac{30.7-6.2}{244}$ or $\tan'x' = \frac{244}{30.7-6.2}$ or $\sqrt{244^2+'24.5'^2}\left(=\sqrt{60136.25}=245.2...\right)$ **and** $\sin'x' = \frac{'24.5'}{'\sqrt{60136.25}'}$ or $\cos'x' = \frac{244}{'\sqrt{60136.25}'}$		3	M1 for suitable trig expression for their choice of variable x to represent either of the (non right-angle) angles in the triangle.
	$\tan^{-1}\left(\frac{'24.5'}{244}\right)$ or $90-\tan^{-1}\left(\frac{244}{'24.5'}\right)$ or $\sqrt{244^2+'24.5'^2}\left(=\sqrt{60136.25}=245.2...\right)$ **and** $\sin^{-1}\left(\frac{'24.5'}{'\sqrt{60136.25}'}\right)$ or $\cos^{-1}\left(\frac{244}{'\sqrt{60136.25}'}\right)$ or $\cos^{-1}\left(\frac{'245.2...'^2+'24.5'^2-244^2}{2\times'245.2...'\times'24.5'}\right)$			M1 using a suitable trig expression to find the angle of depression. **or** for using Pythagoras to find hypotenuse **and** a suitable trig expression to find the angle of depression.
		5.7		A1 answers in the range 5.65 to 5.75 SC B2 for 84.3 (or in the range 84.25 to 84.35) **or** 264.3 (or in the range 264.25 to 264.35) given as answer.
				Total 3 marks

6	$\cos 42 = \frac{x}{9.5}$ or $\tan 42 = \frac{9.5\sin 42}{x}$ or $\sin(90-42) = \frac{x}{9.5}$ or $\frac{x}{\sin(90-42)} = \frac{9.5}{\sin 90}$ or $9.5^2 - (9.5\sin 42)^2$		3	M1 a correct trig statement for x or correct Pythagoras for x^2
	$(x =) 9.5\cos 42$ or $(x =) \frac{9.5\sin 42}{\tan 42}$ or $(x =) 9.5\sin(90-42)$ or $(x =) \frac{9.5\sin(90-42)}{\sin 90}$ or $(x =) \sqrt{9.5^2 - (9.5\sin 42)^2}$ or			M1 a fully correct calculation to find x
		7.1		A1 awrt 7.1
				Total 3 marks

5	$\sin 34 = \frac{x}{6.5}$ or $\frac{x}{\sin 34} = \frac{6.5}{\sin 90}$ oe $6.5^2 - (6.5 \times \cos 34)^2$ or $\cos 56 = \frac{x}{6.5}$ oe		3	M1 a correct trig statement for x
	$(x =)\ 6.5 \times \sin 34$ or $x = \frac{6.5 \times \sin 34}{\sin 90}$ or $(x =) \sqrt{6.5^2 - (6.5 \times \cos 34)^2}$ or $(x =) 6.5 \times \cos 56$ oe			M1 a fully correct method to find x
	Correct answer scores full marks (unless from obvious incorrect working)	3.6		A1 awrt 3.6
				Total 3 marks

3	$\cos 43 = \frac{x}{8.6}$ or $\tan 43 = \frac{8.6\sin 43}{x}$ or $\sin(90-43) = \frac{x}{8.6}$ or $\frac{x}{\sin(90-43)} = \frac{8.6}{\sin 90}$ or $(x^2 =)8.6^2 - (8.6\sin 43)^2$ or $(x^2 =)8.6^2 - 5.8(65...)^2$		3	M1	a correct trig statement for x or QR or a correct Pythagoras statement for x^2
	$(x =)\ 8.6\cos 43$ or $(x =)\frac{8.6\sin 43}{\tan 43}\left(=\frac{"5.8(65...)"}{\tan 43}\right)$ or $(x =)8.6\sin(90-43)$ or $(x =)\frac{8.6\sin 47}{\sin 90}$ or $(x =)\sqrt{8.6^2 - "5.8(65...)"^2}$			M1	a fully correct calculation to find x (some students go straight to this and gain M2)
	Correct answer scores full marks (unless from obvious incorrect working)	6.3		A1	awrt 6.3 seen even if then rounded incorrectly
					Total 3 marks

9	eg $\tan 24 = \frac{6.5}{QR}$ **or** $\frac{6.5}{\sin 24} = \frac{QR}{\sin(180-90-24)}$ oe **or** $\tan(180-90-24) = \frac{QR}{6.5}$ **or** $(PR =) \frac{6.5}{\sin 24} (= 15.9...)$ **and** $6.5^2 + QR^2 = "15.9"^2$		3	M1	for setting up a trig equation in QR **or** for a complete method to find PR **and** then setting up Pythagoras or trig equation for QR
	eg $(QR =) \frac{6.5}{\tan 24}$ **or** $(QR =) \frac{6.5}{\sin 24} \times \sin 66$ **or** $(QR =)\ 6.5 \tan 66$ [where 66 = 180 – 90 − 24] **or** $(QR =) \sqrt{"15.9"^2 - 6.5^2}$			M1	for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)	14.6		A1	accept 14.5 – 14.61
					Total 3 marks

Question	Working	Answer	Mark	Notes
10	24.3 − 16 (= 8.3)		4	M1 Forming a right angled triangle with 24.3 − 16 on one side, 8.3 may be seen on diagram
	$\tan y = \frac{12.5}{"8.3"}$ or $\tan z = \frac{"8.3"}{12.5}$ **OR** $\sqrt{"8.3"^2 + 12.5^2}$ (= 15.004...) **and** $\sin y = \frac{12.5}{"15.0"}$ or $\sin z = \frac{"8.3"}{"15.0"}$ or $\cos y = \frac{"8.3"}{"15.0"}$ or $\cos z = \frac{12.5}{"15.0"}$			M1 for a correct trig statement involving angle *CDE* or *DCE* where *E* is on the line *AD* and *CE* is perpendicular to *AD*
	$\tan^{-1}\left(\frac{12.5}{"8.3"}\right)(= 56.415\ldots)$ or $\tan^{-1}\left(\frac{"8.3"}{12.5}\right)(= 33.584\ldots)$ or $\sin^{-1}\left(\frac{12.5}{"15.0"}\right)(= 56.415\ldots)$ or $\sin^{-1}\left(\frac{"8.3"}{"15.0"}\right)(= 33.584\ldots)$ or $\cos^{-1}\left(\frac{"8.3"}{"15.0"}\right)(= 56.415\ldots)$ or $\cos^{-1}\left(\frac{12.5}{"15.0"}\right)(= 33.584\ldots)$			M1 complete method to find angle *CDE* or *DCE*
		123.6		A1 123.5 − 123.6
				Total 4 marks

Question		Working	Answer	Mark	Notes	
7			47.5	4	M1	Forming a right-angled triangle with angle 125 – 90 marked or 55 marked
		$\tan'35' = \frac{x}{15}$ or $\tan'55' = \frac{15}{x}$ or $\frac{x}{\sin 35} = \frac{15}{\sin 55}$			M1	
		$x = 15 \times \tan$ '35' (= 10.5...) or $x = \frac{15}{\tan'55'}$ (= 10.5…) or $x = \frac{15}{\sin 55} \times \sin 35$ (= 10.5…)			M1	
		10.5 + 37			A1	awrt 47.5
8	(a)		$3k^3m$	2	B2	B1 for an answer in the form ak^xm^y with 2 correct from $a = 3$, $x = 3$, $y = 1$
	(b)	$7 + 1 < 4x \leq 17 + 1$ or $\frac{7}{4} < x - \frac{1}{4} \leq \frac{17}{4}$	$2 < x \leq 4.5$	3	M1	or one side of the inequality correct, e.g. 2 or 4.5
		$(7+1) \div 4 < x \leq (17+1) \div 4$ or $\frac{7}{4} + \frac{1}{4} < x \leq \frac{17}{4} + \frac{1}{4}$			M1	
					A1	Accept $x > 2$, $x \leq 4.5$

					Total 6 marks

12		$(ED=)\frac{16.7}{\tan 43}$ (=17.90855...) **or** $(CD=)\frac{16.7}{\sin 43}$ (= 24.48686...)			M1 for a correct method to find length *CD* or *ED* (*E* is the point on line *AD* from where a vertical line is drawn downwards from point *C*) NB. Sine rule may be used
		$(ED=)\frac{16.7}{\tan 43}$ (=17.90855...) **and** $(CD=)\frac{16.7}{\sin 43}$ (= 24.48686...)			M1 for a correct method to find both *CD* **and** *ED* **or** use of Pythagoras theorem $(CD=)\sqrt{16.7^2+'17.90....'^2}$ (= 24.48686...) $(ED=)\sqrt{'24.48....'^2-16.7^2}$ (=17.90855...) NB. Sine rule must be in the correct form to give the answer
		16.7 + 21.2 × 2 + '24.5' + '17.9' (= 101.495...)			M1 (dep on M2) complete method with no extra sides
			101	4	A1 accept 101 – 102
					Total 4 marks

14	(*AOC* =) 38 × 2 (= 76)		4	M1
		52		A1
				B2 (dep on M1) for all reasons relevant to their method – underlined words must be seen. angle at the centre is 2 × (double) angle at circumference / angle at circumference is ½ angle at centre angles in a triangle add to 180° **or** angles in a triangle add to 180° base angles in an isosceles triangle (are equal) If not B2 then award B1 (dep on M1) for a correct circle theorem
				Total 4 marks

15	e.g. (*EF* =) 12cos40 (= 9.19...) **or** (*FD* =) 12sin40 (= 7.71...) **and** (*EF* =) $\sqrt{12^2 - "7.71"^2}$ (= 9.19...)			M2 complete method to find *EF* (if not M2 then M1 for a correct statement involving *EF* e.g. $\frac{EF}{12} = \cos 40$)
	e.g. $\frac{"9.19"}{EG} = \tan 28$ or $\tan 62 = \frac{EG}{"9.19"}$ **or** $\frac{"9.19"}{FG} = \sin 28 (= 19.5...)$ **and** $"19.5"^2 - "9.19"^2 (= 298.9...)$			M1 (dep on M2) for a correct trig statement involving *EG* **or** complete method to find *FG* **and** a correct start to Pythagoras process
		17.3	4	A1 accept 17.2 – 17.3
				Total 4 marks

10	e.g. $\sin 65 = \frac{16}{AB}$ **or** $\cos 25 = \frac{16}{AB}$ **or** $\frac{AB}{\sin 90} = \frac{16}{\sin 65}$ **or** $\tan 65 = \frac{16}{AD}$ **or** $\tan 25 = \frac{AD}{16}$ **or** $\frac{AD}{\sin 25} = \frac{16}{\sin 65}$		4	M1	for a correct trig ratio for *AB* **or** *AD* accept 180 – 90 – 65 for 25
	e.g. $(AB =) \frac{16}{\sin 65} (= 17.654\ldots)$ **or** $(AB =) \frac{16}{\cos 25} (= 17.654\ldots)$ **or** $(AB =) \frac{16 \sin 90}{\sin 65} (= 17.654\ldots)$ **and** $(AD =) \frac{16}{\tan 65} (= 7.460\ldots)$ **or** $(AD) = 16 \times \tan 25 (= 7.460\ldots)$ **or** $(AD =) \frac{16 \sin 25}{\sin 65} (= 7.460\ldots)$			M1	for finding *AB* **and** *AD* Allow use of Pythagoras $(AD =) \sqrt{"17.654..."^2 - 16^2} (= 7.460\ldots)$ or $(AB =) \sqrt{"7.460..."^2 + 16^2} (= 17.654\ldots)$
	("17.654…" × 2) + ("7.460…" × 2) oe			M1	for a complete method to find the perimeter
		50.2		A1	accept 49.6 – 50.6
					Total 4 marks

10	eg $\cos 38 = \frac{9.3}{(AB)}$ oe **or** $\sin'52' = \frac{9.3}{(AB)}$ oe **or** $\frac{(BC)}{\sin 38} = \frac{2\times 9.3}{\sin'104'}$ oe or $\frac{\sin'52'}{9.3} = \frac{\sin 90}{(BC)}$ oe		4	M1 or $BN = \frac{9.3\sin 38}{\sin'52'}$ or $9.3\tan 38 (= 7.2659...)$ **and** $(AB^2) = 9.3^2 + '7.2659...'^2$
	eg $(AB =) \frac{9.3}{\cos 38}$ $(= 11.80....)$ **or** $(AB =) \frac{9.3}{\sin'52'}$ $(= 11.80....)$ **or** $(BC =) \frac{2\times 9.3\times \sin 38}{\sin'104'} (= 11.80\ldots)$ oe			M1 or $(AB =) \sqrt{9.3^2 + '7.2659...'^2}\ (= 11.80...)$
	'11.8' + '11.8' + 9.3 + 9.3 or '11.8' × 2 + 9.3 × 2 oe			M1
	Correct answer scores full marks (unless from obvious incorrect working)	42.2		A1 awrt 42.2
				Total 4 marks

10	$\sin 52 = \frac{12 \div 2}{r}$ oe **or** $\frac{r}{\sin 90} = \frac{6}{\sin 52}$ oe **or** $\cos(90-52) = \frac{12 \div 2}{r}$ oe **or** $(r^2 =)(12 \div 2)^2 + \left(\frac{12 \div 2}{\tan 52}\right)^2$ oe $\left[r^2 = 6^2 + 4.687...^2\right]$ **or** $\frac{r}{\sin 38} = \frac{12}{\sin 104}$ oe		4	M1	A correct trig statement for the radius use of tan must also include a correct Pythagoras statement.
	$r = \frac{6}{\sin 52}$ (=7.614) oe **or** $r = \frac{6}{\cos 38}$ oe **or** $(r =)\sqrt{(12 \div 2)^2 + \left(\frac{12 \div 2}{\tan 52}\right)^2}$ $\left[r = \sqrt{6^2 + 4.687...^2}\right]$ oe **or** $\frac{12 \sin 38}{\sin 104}$ oe			M1	A correct method to find the radius of the circle use of tan must also use Pythagoras to find an expression for r
	(Area =) $\pi \times (\text{"7.61..."})^2$			M1	the radius must come from a completely correct method
	Correct answer scores full marks (unless from obvious incorrect working)	182		A1	Accept 181 - 183
					Total 4 marks

12	$\cos BAD = \frac{8}{14}$ **or** $\sin ABD = \frac{8}{14}$ **or** $\sin ABD = \frac{8\sin 90}{14}$ **or** $(BD =)\sqrt{14^2 - 8^2}\ \left(=\sqrt{132} = 2\sqrt{33} = 11.4(89...)\right)$		4	M1
	$BAD = \cos^{-1}\left(\frac{8}{14}\right)\ (= 55.(15\ldots))$**or** $\cos^{-1}\left(\frac{14^2 + 8^2 - "11.489"^2}{2\times 14\times 8}\right)$ $BAD = \sin^{-1}\left(\frac{"11.489..."}{14}\right)\ (= 55.(15\ldots))$ **or** $BAD = \tan^{-1}\left(\frac{"11.489..."}{8}\right)(= 55.(15\ldots))$ **or** $BAD = 180 - 90 - \sin^{-1}\left(\frac{8}{14}\right)(= 180 - 90 - 34.8... = 55.(15...)$ oe **or** $CAD = 180 - 38 - \sin^{-1}\left(\frac{8}{14}\right) - 90\quad (= 180 - 38 - 34.8 - 90\ = 17.2)$			M1
	$\tan("55.15..." - 38) = \frac{CD}{8}$ oe eg $\tan 17.2 = \frac{CD}{8}$ $\frac{CD}{\sin(55.1... - 38)} = \frac{8}{\sin(90 - (55.1... - 38))}$ oe			M1 A correct equation with *CD* being the only unknown value
	Correct answer scores full marks (unless from obvious incorrect working)	2.47		A1 2.44 – 2.48
				Total 4 marks

12	eg $\tan 47 = \frac{(BD)}{4250}$ **or** $\tan 24 = \frac{4250}{(BC)}$ **or** $\tan(47+"19") = \frac{(BC)}{4250}$ **or** $\frac{(BD)}{\sin 47} = \frac{4250}{\sin 43}$ **or** $(AD =) \frac{4250}{\cos 47} (= 6231.686...)$ **or** $(AD =) \frac{4250}{\sin 43} (= 6231.686...)$ **or** $(AC =) \frac{4250}{\sin 24} (= 10449.021...)$ **or** $(AC =) \frac{4250}{\cos 66} (= 10449.021...)$		4	M1
	eg $(BD =) 4250 \tan 47 (= 4557.567...)$ **or** $(BC =) \frac{4250}{\tan 24} (= 9545.656...)$ **or** $(BD =) \frac{4250}{\sin 43} \times \sin 47 (= 4557.567...)$ **or** $\frac{(DC)}{\sin"19"} = \frac{"10449....."}{\sin"137"}$ **or** $\frac{(DC)}{\sin"19"} = \frac{"6231.686"}{\sin 24}$ **or** $(BC =) 4250 \times \tan(47+"19") (= 9545.656...)$ **or** $(DC^2 =) "6231"^2 + "10449"^2 - 2 \times "6231" \times "10449" \times \cos 19$			M1
	eg "9545.656" – "4557.567" (= 4988.089) **or** $(DC =) \frac{"6231.686"}{\sin 24} \times \sin 19$ **or** $(DC =) \frac{"10449....."}{\sin"137"} \times \sin"19"$ **or** $(DC =) \sqrt{"6231"^2 + "10449"^2 - 2 \times "6231" \times "10449" \times \cos 19}$			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)	4988		A1 allow in the range 4932 – 4990

Question	Working	Answer	Mark	Notes
9	E.g. $\tan 72 = \frac{12.8}{a}$ **or** $\tan(90-72) = \frac{o}{12.8}$ **or** $\sin 72 = \frac{12.8}{h}$ **or** $\cos(90-72) = \frac{12.8}{h}$	110	5	M1 substitutes correctly into a trig ratio (including the Sine rule)
	E.g.(shortest side) = $\frac{12.8}{\tan 72}$ **or** 12.8tan(90 – 72) **or** 4.15(89…) **or** 4.16 **or** (hypotenuse =) $\frac{12.8}{\sin 72}$ **or** $\frac{12.8}{\cos(90-72)}$ **or** 13.4(58…) **or** 13.5			M1 for a complete method to find one side of the triangle
	One of (shortest side =) $\frac{12.8}{\tan 72}$ **or** 12.8tan(90 – 72) **or** 4.15(89…) **or** 4.16 **or** $\sqrt{"13.4..."^2 - 12.8^2}$ **AND** **One of** (hypotenuse =) $\frac{12.8}{\sin 72}$ **or** $\frac{12.8}{\cos(90-72)}$ **or** 13.4(58…) **or** 13.5 **or** $\sqrt{12.8^2 + "4.15..."^2}$			M1 for a complete method to find both missing sides of triangle NB Could use Pythagoras's theorem with side found – must be a complete correct method
	5 × ("13.4(58…)" – "4.15(89…)") + 5 × 12.8 **or** 5 × ("13.4…" + "4.15…" + 12.8) – 10 × "4.15…"			M1 for method to use found lengths to find perimeter A1 for answer in range 110 - 111

Question	Working	Answer	Mark	Notes
10	**Working with *CD* and then triangle *ABD***			
	E.g. $\tan 20 = \frac{CD}{13}$			M1 for a correct statement or equation including *CD* as the only variable E.g. $CD^2 = \left(\frac{13}{\cos 20}\right)^2 - 13^2$
	E.g. (*CD* =) 13tan20 **or** 4.7(316...)			M1 for a correct method to find *CD* E.g. $\sqrt{\left(\frac{13}{\cos 20}\right)^2 - 13^2}$
	E.g. $\tan(BAD) = \frac{8 + "4.73"}{13}$ **or** $\tan(BAD) = 0.97(93...)$			M1 for a correct statement or equation including angle *BAD* as the only variable
	E.g. (BAD =) $\tan^{-1}("0.979")$ **or** 44.4(024...)			M1 for a correct method to find angle *BAD*
		24.4	5	A1 for 24.3 - 24.41 Award M1A1M1M1A0 for an answer in the range 44.3 – 44.41

Question	Working	Answer	Mark	Notes
10	**Alternative mark scheme – working with *AC* and then triangle *ABC***			
	E.g. $\cos 20 = \frac{13}{AC}$			M1 for a correct statement or equation including *AC* as the only variable E.g. $AC^2 = 13^2 + (13\tan 20)^2$
	E.g. $(AC =) \frac{13}{\cos 20}$ **or** 13.8(3…)			M1 for a correct method to find *AC* E.g. $\sqrt{13^2 + (13\tan 20)^2}$
	E.g. $(AB =) \sqrt{"13.8"^2 + 8^2 - 2\times 13.8\times 8\times \cos(110)}$ (=18.1(9..) **or** 18.2			M1 for a correct method to find *AB*
	E.g. $\frac{\sin BAC}{8} = \frac{\sin 110}{"18.1"}$ **or** $8^2 =$ "13.8"^{2} + "18.1"^{2} – 2 × "13.8"×"18.1"×cos *BAC*			M1 for a correct statement or equation including angle *BAC* as the only variable
		24.4	5	A1 for ans in range 24.3 - 24.41 Award M4A0 for an answer in the range 44.3 – 44.41

12	$y=\frac{7-5x}{2}$ or $y=\frac{7}{2}-\frac{5}{2}x$ or $y=3.5-2.5x$ or $2y=7-5x$ oe		2	M1 for making y or $2y$ the subject Allow $y=-\frac{5}{2}x+c$ oe
		-2.5		A1 for $-\frac{5}{2}$ or -2.5
				Total 3 marks

13	$\cos 35°=\frac{15}{AB}$ or $\sin 55°=\frac{15}{AB}$ or $\frac{15}{\sin 55}=\frac{JB}{\sin 35}$ **and** $(AB^2=)("10.50")^2+15^2$ or $\tan 35°=\frac{JB}{15}$ **and** $(AB^2=)("10.50")^2+15^2$		5	M1 oe eg x for AB
	$(AB=)\frac{15}{\cos 35°}$ (=18.3…) **or** $(AB=)\frac{15}{\sin 55°}$ (=18.3…) **or** $(AB=)\sqrt{("10.50")^2+15^2}$ **or** $(AB=)\sqrt{(15\tan 35)^2+15^2}$			M1
	'18.3' × 4 (= 73.2)			M1 dep 1st M1
	80 – '18.3' × 4 or 80 – '73.2'			M1 dep 1st M1
		6.75		A1 accept 6.75 – 6.8
				Total 5 marks

Alternative Mark Scheme for Q13 [do not mix and match with above MS]					
13	15×4 (= 60)		5	M1	
	$\cos 35° = \frac{'60'}{AE}$ or $\sin 55° = \frac{'60'}{AE}$			M1	
	$(AE =) \frac{'60'}{\cos 35°}$ (= 73.2) or $(AE =) \frac{'60'}{\sin 55°}$ (= 73.2)			M1	dep 1st M1
	80 – '73.2'			M1	
		6.75		A1	accept 6.75 – 6.8
					Total 5 marks

14	(a)	35 37 38 39 41 42 43 44 45 47 47		3	M1	Ordering values (allow 1 error) error may include missing a value May be implied by correct values for LQ **and** UQ.
					M1	LQ = 38 **and** UQ = 45 identified
			7		A1	
	(b)		January and reason using IQR	1	B1	ft from part (a) January as the IQR is lower oe ignore irrelevant statements about the median if given in addition to correct statements about IQR.
						Total 4 marks

10	eg $\tan BAP = \frac{2}{5}$ or $\sin BAP = \frac{2}{\sqrt{5^2+2^2}}$ or $\frac{\sin BAP}{2} = \frac{\sin 90}{\sqrt{5^2+2^2}}$ $\cos BAP = \frac{5}{\sqrt{5^2+2^2}}$ or $\cos BAP = \frac{5^2+(\sqrt{5^2+2^2})^2-2^2}{2\times5\times\sqrt{29}}$		5	M1	for setting up a trig equation for angle *BAP*
	eg $(BAP =)\tan^{-1}\left(\frac{2}{5}\right)(= 21.8...)$ or $(BAP =)\sin^{-1}\left(\frac{2}{\sqrt{5^2+2^2}}\right)$ or $(BAP =)\sin^{-1}\left(\frac{2\sin 90}{\sqrt{5^2+2^2}}\right)$ $(BAP =)\cos^{-1}\left(\frac{5}{\sqrt{5^2+2^2}}\right)$ or $BAP = \cos^{-1}\left(\frac{5^2+(\sqrt{5^2+2^2})^2-2^2}{2\times5\times\sqrt{5^2+2^2}}\right)$			M1	for a complete method to find angle *BAP* (= 21.8….) [M2 for $90 - \tan^{-1}\frac{5}{2}$ ie 90 – 68.2]
	eg (int angle =) $(6-2)\times180\div6(=120)$ **or** (ext angle =) $360\div6(=60)$			M1	**Indep** for a method to find the size of one interior **or** one exterior angle in a regular hexagon – **could be seen on diagram**
	eg "120" – "21.8" **or** 180 – "60" – "21.8"			M1	for a complete method to find angle *PAF* where all values have come from a correct method
		98.2		A1	accept 98.1 – 98.3
					Total 5 marks

7	1 – (0.24 + 0.4) (= 0.36) oe or $3x + x = 1 – (0.24 + 0.4)$ oe		4	M1
	48 ÷ 0.24 (= 200) or "0.36" ÷ 4 (= 0.09) or "0.36" ÷ 4 × 3 (= 0.27)			M1
	"0.27" × "200" or "200" × "0.36" ÷ 4 × 3 ("200" – 48 – "80") ÷ 4 × 3			M1 for a complete method
		54		A1
				Total 4 marks

7 **ALT**	1 – (0.24 + 0.4) (= 0.36) oe or $3x + x = 1 – (0.24 + 0.4)$ oe		4	M1
	48 ÷ 24 (= 2) oe or $\left(\frac{"0.36"}{4}\times 3\right)\div 0.24\left(=\frac{9}{8}=1.125\right)$ oe or $\left(\frac{"36"}{4}\times 3\right)\div 24\left(=\frac{9}{8}=1.125\right)$ oe			M1
	$"2"\times\left(\frac{"36"}{4}\times 3\right)$ oe or $"\frac{9}{8}"\times 48$ oe or $("27"\div 24)\times 48$ oe			M1 for a complete method
	Correct answer scores full marks (unless from obvious incorrect working)	54		A1
				Total 4 marks

8	$\cos 50 = \frac{18}{(AB)}$ or $\sin 40 = \frac{18}{(AB)}$ or $\frac{(AB)}{\sin 90} = \frac{18}{\sin 40}$		5	M1	M2 for $(AB) = \sqrt{18^2 + (18\tan 50)^2}$ oe (= 28.0030…) or 28
	$(AB) = \frac{18}{\cos 50} (= 28.0030...)$ oe or 28 or $(AB) = \frac{18}{\sin 40} (= 28.0030...)$ oe or 28			M1	
	$\frac{1}{2} \times \pi \times$ "28.0030..." $(= 43.9...)$ oe or 44 $\pi \times$ "28.0030..." $(= 87.9...)$ oe or 88			M1 for use of πd or $\frac{1}{2}\pi d$ oe Allow any value of $AB > 18$ if M2 not scored	
	"28…" + "43.9…" (= 71.9900…) or "28" + "44"			M1ft from previous M1 Allow *their d* + *their* $\frac{1}{2}\pi d$	
	Correct answer scores full marks (unless from obvious incorrect working)	72		A1 awrt 72	
				Total 5 marks	

9	(a)		0.000 625	1	B1
	(b)	25 000 000 oe e.g. 25×10^6 or 0.25×10^8 **or** 2.5×10^n $n \neq 7$		2	M1
		Correct answer scores full marks (unless from obvious incorrect working)	2.5×10^7		A1
					Total 3 marks

12	(a)	$\tan 20 = \frac{100}{d}$ oe or $\tan(90-20) = \frac{d}{100}$ oe or $\frac{d}{\sin(90-20)} = \frac{100}{\sin 20}$ oe		3	M1
		$(d =) \frac{100}{\tan 20} (= 274.747\ldots)$ or $(d =) 100 \times \tan(90-20) (= 274.747\ldots)$ or $(d =) \frac{100}{\sin 20} \times \sin(90-20) (= 274.747\ldots)$			M1
		Correct answer scores full marks (unless from obvious incorrect working)	275		A1 awrt 275
	(b)	$\tan 25 = \frac{100+h}{275}$ oe or $\tan 25 = \frac{y}{275}$ oe or $275 \times \tan 25 (= 128....)$ or $\tan(90-25) = \frac{275}{100+h}$ oe or $\tan(90-25) = \frac{275}{y}$ oe or $\frac{100+h}{\sin 25} = \frac{275}{\sin(90-25)}$ or 128.1 – 128.2 (y is the height of cliff and radio mast)		3	M1 ft part (a) Allow $(hyp =) \sqrt{100^2 + 275^2}$ $(= \sqrt{85486.321} = 292.380)$ or $(hyp =) \frac{100}{\sin 20} \times \sin 90 (= 292.380)$
		$(h =) 275 \times \tan 25 - 100 = 28.1169...$ or $(h =) \frac{275}{\tan(90-25)} - 100 (= 28.1169...)$ or $(h =) \frac{275}{\sin(90-25)} \times \sin 25 - 100 (= 28.1169...)$			M1 ft part (a) $(h =) \frac{"292.380"}{\sin(90-25)} \times \sin(25-20)$ $(= 28.1169...)$
		Correct answer scores full marks (unless from obvious incorrect working)	28.1		A1 Accept answers in the range 28 – 28.2
					Total 5 marks

Question	Working	Answer	Mark	Notes
18	$14^2 = 10^2 + 8^2 - 2 \times 10 \times 8 \times \cos A$ **or** $\cos A = \frac{10^2+8^2-14^2}{2\times 8\times 10}$ oe		3	M1 Correct substitution in cosine rule for **any** angle or for 44.4... or 34.047....(the other 2 angles to 1dp or better)
				M1 $\cos^{-1}\left(\frac{10^2+8^2-14^2}{2\times 10\times 8}\right)$ oe ie $\cos^{-1}$ of the correct angle **or** a fully correct method to find the largest angle eg $180-\cos^{-1}\left(\frac{196+100-64}{280}\right)-\cos^{-1}\left(\frac{196+64-100}{224}\right)$ oe
		101.5		A1 101.5 to 101.6
				Total 3 marks

19	$BE^2 = 10^2 + 24^2 + 8^2$ (= 100 + 576 + 64 = 740) ($BE = 2\sqrt{185}$ =27.202 ...)	$BD^2 = 8^2 + 24^2$ (=64 + 576 = 640) ($BD = 8\sqrt{10}$ = 25.298....)		3	M1 Complete method to find BE or BE^2 or BD or BD^2
	$\sin DBE = \frac{10}{\sqrt{"740"}}$ (= 0.3676 ...)	$\tan DBE = \frac{10}{\sqrt{"640"}}$ (= 0.3952...) **or** $\cos DBE = \frac{\sqrt{"640"}}{\sqrt{"740"}}$ (=0.9428...)			M1 Allow use of sine or cosine rule $\sin DBE = \frac{10\sin 90}{\sqrt{"740"}}$ **or** $\cos DBE = \frac{"640"+"740"-10^2}{2\times\sqrt{"640"}\times\sqrt{"740"}}$ (=0.9299...)
			21.6		A1 21.5 – 21.6
					Total 3 marks

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

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

15	$\frac{1}{2}\times 6\times 11\times \sin 118 (= 29.1...)$		3	M1 for the area of half of the kite
	eg $2\times\frac{1}{2}\times 6\times 11\times \sin 118$			M1 for a complete method
		58.3		A1 accept 58.2 – 58.3
				Total 3 marks

16		C, F, D, H	3	B3 for all 4 correct (B2 for 2 or 3 correct) (B1 for 1 correct)
				Total 3 marks

15	eg $0.5 \times EF \times FG \times \sin 130 = 74$ oe **or** eg $EF \times FG \times \sin 130 = 2 \times 74$ oe		3	M1	for setting up an equation using the area of a triangle formula
	$\left(EF^2 =\right)\frac{2\times74}{\sin 130}$ (= 193.2...) oe **or** $(EF =) \sqrt{\frac{2\times74}{\sin 130}}$ $\left(=\sqrt{193.2...}\right)$ oe			M1	for a complete method to find EF^2 **or** EF
	Correct answer scores full marks (unless from obvious incorrect working)	13.9		A1	awrt 13.9
					Total 3 marks

15	360 ÷ 5 (= 72) oe or (5 – 2)×180 ÷ 5 (= 108) oe or 540 ÷ 5 (= 108) oe		3	M1 for a method to find an exterior or interior angle for a regular pentagon Do not award this mark if 108 is assigned as an exterior angle or 72 is assigned as an interior angle Ignore angles on the diagram other than exterior/interior angles of the pentagon even if incorrectly labelled
	$\frac{1}{2}\times 6.5\times 3\times\sin[angle\ DCE]$ oe or $(h=)6.5\times\sin[angle\ DCE]$ (= 6.18….) **and** $\frac{1}{2}\times 3\times$"6.18..." oe			M1 ft their angle *DCE* when substituting in $\frac{1}{2}\times 6.5\times 3\times\sin[angle\ DCE]$ [*angle DCE*] means their angle *DCE* provided it is less than 90°
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	9.27		A1 accept 9.26 – 9.28 SC B2 for $\frac{1}{2}\times 6.5\times 3\times\sin$"108" = 9.27…
				Total 3 marks

16	(i)		**E**	1	B1
	(ii)		**A**	1	B1
					Total 2 marks

Question	Working	Answer	Mark	Notes
17	$(AC^2 =)\ 4.1^2 + 5.3^2 - 2\times4.1\times5.3\times\cos(110)$			M1 for the correct use of Cosine rule to find AC
	$(AC =)\ \sqrt{16.81 + 28.09 + 14.8(641...)}$ or $\sqrt{59.7(641...)}$ or $7.7(3073)$ **or** $AC^2 = 59.7\ldots$			M1 NB: there must be evidence of correct order of operations for this mark to be awarded
	Eg $\frac{\sin x}{5.3} = \frac{\sin 110}{"7.7"}$ **or** $\frac{5.3}{\sin x} = \frac{"7.7"}{\sin 110}$ **or** $5.3^2 = 4.1^2 + "7.7"^2 - 2\times4.1\times"7.7"\times\cos x$ oe			M1 dep on first M1 for correct use of sine rule **or** cosine rule ft for their value of AC or AC^2
	Eg $\sin x = \frac{\sin 110}{"7.7"}\times5.3\ (=0.644(2\ldots))$ **or** $\cos x = \frac{4.1^2 + "7.7"^2 - 5.3^2}{2\times4.1\times"7.7"}\ (=0.764(83\ldots))$			M1 for isolating $\sin x$ or $\cos x$
		40.1	5	A1 for 40.1 – 40.11

Question	Working	Answer	Mark	Notes
20	Let N be the midpoint of BC Let sides of cube have length $2a$ cm $AN^2 = 4a^2 + a^2 (= 5a^2)$ or $AM^2 = 4a^2 + a^2 + 4a^2 (= 9a^2)$ eg $\tan MAN = \frac{2a}{\sqrt{"5a^2"}}$ or $\sin MAN = \frac{2a}{\sqrt{"9a^2"}}$	41.8	4	B1 for recognising that required angle is MAN (could be marked on a diagram) M1 any $a > 0$ (a could be a number or a letter) M1 correct trig statement for angle MAN, any $a > 0$ (a could be a number or a letter) A1 41.8 - 41.82
21	$x^2 = 5^2 + y^2 - 2\times5\times y\cos 60^\circ$ $(y-1)^2 = 5^2 + y^2 - 5y$ **or** $x^2 = 5^2 + (x+1)^2 - 5x - 5$ $y^2 - 2y + 1 = 25 + y^2 - 5y$ **or** $x^2 = 5^2 + x^2 + 2x + 1 - 5x - 5$ $5y - 2y = 25 - 1$ **or** $y = 8$ **or** $3x = 21$ **or** $x = 7$	20	5	M1 recognising need for the cosine rule M1 M1 for expansion of $(y-1)^2$ or $(x+1)^2$ in a correct equation M1 for correct linear equation with correct isolation of terms A1

Question		Working	Answer	Mark	Notes	
19		$\frac{BD}{\sin 97} = \frac{9.3}{\sin 58}$ $BD = \frac{9.3}{\sin 58} \times \sin 97$ (= 10.8846..) 0.5 × '10.88.' × 11.2 × sin47 (= 44.57.....) 0.5 × '10.88..' × 9.3 × sin25 (=21.39.....) or 0.5 × '4.63458 …' × 9.3 × sin97 (=21.39.....)	66.0	5	M1 M1 M1 M1 A1	 Complete method to find area *BCD* Complete method to find area *ABD* Allow 65.9 – 66.1
20	(a)	$3(x^2 - 4x) + 7$ or $3\left(x^2 - 4x + \frac{7}{3}\right)$ $3((x-2)^2 - 4) + 7$ or $3\left((x-2)^2 - 4 + \frac{7}{3}\right)$ or $3(x-2)^2 - 12 + 7$	$3(x-2)^2 - 5$	3	M1 M1 A1	or expanding $a(x^2+2bx+b^2)+c$ $-12 = 2ab$ or $7 = ab^2 + c$ or $a = 3$, $b = -2$, $c = -5$
	(b)		$x = 2$	1	B1	ft from (a)

Question		Working	Answer	Mark	Notes	
12		$\sin 32 = \frac{BD}{3.1}$ oe $(BD =) 3.1 \times \sin 32$ (= 1.6427...) $\cos 42 = \frac{"3.1\sin 32"}{AB}$ oe or $\frac{AB}{\sin 90} = \frac{"3.1 \sin 32"}{\sin 48}$ oe $AB = \frac{"3.1\sin 32"}{\cos 42}$ or $AB = \frac{"3.1 \sin 32"}{\sin 48}$	2.21	5	M1 M1 M1 M1 A1	A correct calculation involving *BD* Accept 1.6 or better Dep or (*AD* =) "1.6.. x tan 42 {= 1.479} Or (*AB* =) $\sqrt{"1.479"^2 + "1.6427"^2}$ 2.21053... (Accept 2.2 → 2.22)
						Total 5 marks

13	(a)	Plotting points from table at ends of interval (40, 6), (50, 20), (60, 56), (70, 84), (80,95), (90, 100) Points joined with curve or line segments	Correct cf diagram	2	M1 A1	$\pm$½ sq (at least 5 points plotted correctly) Or all points plotted consistently within each interval at the correct heights Accept cf graph which is not joined to (30,0)
	(b)	Use of graph at 50	58 – 59	2	M1 A1	Use of graph at 50 walkers No working shown and answer is within 58 – 59 award M1A1
	(c)	86 or 87 or 88 indicated on graph or stated 100 – "86" or 100 – "87" or 100 – "88"	$\frac{12}{100}$ oe $\frac{13}{100}$ oe $\frac{14}{100}$	3	M1 M1 A1	Use of their graph at 72 minutes Dep e.g. 12, 13 or 14 walkers 0.12 → 0.14 inc, oe
						Total 7 marks

14	(a)	x^0y^6	x^0y^6	2	B1B1	Allow B1 if $(x^3y^2)^3$ or $(x^{36}y^{24})^{0.25}$ seen on answer line
	(b)	$3^n = \frac{3^x}{3^{2y}}$	$n = x - 2y$	2	M1 A1	for a correct first step e.g. 3^{2y} or 3^{-2y}
						Total 4 marks

12	(a)	E.g. 56 – 38		2	M1 for subtracting readings from 60 and 20 oe
			18		A1 for answer in the range 17 – 19
	(b)	[40.5, 43]		3	B1
		'42' ÷ 0.6 oe			M1 for complete method to find the number of men
			70		A1
					Total 5 marks

13		$0.14 = \frac{56}{w^2}$ oe **or** 56 ÷ 0.14 (= 400)		4	M1 for using the given formula correctly
		$\sqrt{\frac{56}{0.14}}$ **or** $\sqrt{'400'}$ (=20)			M1 for a method to find w
		'20' × '20' × '20' oe			M1 (dep on M2) for a method to find the volume of the cube
			8000		A1
					Total 4 marks

14	(a)	(0.5 ×) 9.3 × 14.7 × sin106 **or** (9.3 × cos 16) × 14.7 **or** (9.3 × sin 74) × 14.7		2	M1 for applying the area of a triangle formula using correct values (to find half of the area of the parallelogram) **or** for a correct method to find the area of the parallelogram
			131		A1 awrt 131
	(b)	(GE^2 =) $9.3^2 + 14.7^2 – 2 \times 9.3 \times 14.7 \times \cos 106$		3	M1 for the correct use of the cosine rule
		377(.9….) **or** 378 **or** 86.49 + 216.09 + 75.3… **or** 302.58 + 75.3….			M1 (dep on M1)for the correct order of operations
			19.4		A1 for 19.4 – 19.5
					Total 5 marks

18	(AC^2 =) $9^2 + 12^2 - 2 \times 9 \times 12 \times \cos 60$ (= 117) or (AC^2 =) 81 + 144 – 108 (= 117) oe		5	M1 oe eg $BM = 9\cos 60 (= 4.5)$ **and** $AM = 9\sin 60 (= \frac{9\sqrt{3}}{2})$ **and** $AC^2 = '(\frac{9\sqrt{3}}{2})'^2 + (12 - '4.5')^2$ (where *AM* is perpendicular to *BC*)
	(AC =)$\sqrt{117}$ or $3\sqrt{13}$ or 10.8(16653…)			A1 oe
	(area *ABC* =)0.5 × 9 × 12 × sin 60 (= $27\sqrt{3}$ or 46.7(653….))			M1 indep or $\frac{1}{2} \times '(\frac{9\sqrt{3}}{2})' \times 12$ (= $27\sqrt{3}$) oe
	(area *ACD* =)0.5 × 7 × '$\sqrt{117}$' × sin 84 (=37.6(50896…))			M1 dep on 1st M1
	Working required	84.4		A1 dep on M3 awrt 84.4
				Total 5 marks

16	$\frac{1}{2}\times 45\times 36\times \sin 'C'$ (= 405)	**alternative** $\frac{2\times 405}{36}(=22.5)$ **or** $\frac{2\times 405}{45}(=18)$		5	M1 correct substitution into the sine area formula, with their choice of symbol to represent *C*. **or** work out the perpendicular height with *BC* or *CD* as the base.
	$\sin 'C' = \left(\frac{405\times 2}{45\times 36}\right)$ ('C' = 30) oe	$\sqrt{45^2-22.5^2}\ (=\sqrt{1518.75}=38.97)$ or $\sqrt{36^2-18^2}\ (=\sqrt{972}=31.17)$			M1 correct rearrangement to make sin *C* the subject **or** use Pythagoras with their found perpendicular height.
	$(BD=)\sqrt{45^2+36^2-2\times 45\times 36\times \cos '30'}$ $(=\sqrt{3321-3240\times \cos '30'})$ $(=\sqrt{515.077...}=22.695...)$	$\sqrt{('38.97'-36)^2+22.5^2}\ (=\sqrt{515.077...})$ or $\sqrt{('45'-31.17)^2+18^2}\ (=\sqrt{515.077...})$			M1 (dep on 1st M1, ft 30) correct expression for *BD* ft their *C* (must be less than 90°). **or** use Pythagoras to find an expression for *BD*.
	$\cos 'ABD' = \left(\frac{'22.695...'^2+19^2-28^2}{2\times '22.695...'\times 19}\right)$ leading to '*ABD*' = **or** $(BAD=)\ \cos^{-1}\left(\frac{28^2+19^2-'22.695...'^2}{2\times 28\times 19}\right)$ (= 53.7…) **and** $\sin 'ABD' = \frac{\sin '53.7'}{'22.695...'}\times 28$ leading to '*ABD*' =				M1 for a complete method to find angle *ABD*
			83.9		A1 accept 83.85 – 83.9
					Total 5 marks

18	$(AC^2 =)\ 9.7^2 + 12.3^2 - 2 \times 9.7 \times 12.3 \times \cos 115$		5	M1 for the correct use of cosine rule
	$(AC^2 =)\ 346(.2\ldots)$ **or** $(AC =)\ \sqrt{346(.2....)}$ or 18.6…			A1 for 346 or $\sqrt{346(.2....)}$ or 18.6…
	$\frac{\sin x}{9.7} = \frac{\sin 115}{"\sqrt{346}"}$ oe or $9.7^2 = "\sqrt{346}"^2 + 12.3^2 - 2\times"\sqrt{346}"\times 12.3\times\cos x$ or $\frac{1}{2}\times 9.7\times 12.3\times\sin 115 = \frac{1}{2}\times 12.3\times"\sqrt{346}"\times\sin x$ oe			M1 use of their *AC* dep on first M1 for correct use of sine rule **or** cosine rule **or** for setting up an equation using the area of a triangle formula to find sin *x*
	$\sin x = 9.7\times\frac{\sin 115}{"\sqrt{346}"}$ oe or $\sin x = 0.47...$ or $\cos x = \frac{"\sqrt{346}"^2 + 12.3^2 - 9.7^2}{2\times"\sqrt{346}"\times 12.3}$ or $\cos x = 0.88...$			M1 use of their *AC* dep on first M1 Allow $(x =)\sin^{-1}(....)$ or $(x =)\cos^{-1}(....)$
		28.2		A1 awrt
				Total 5 marks

17	(area PQS =) $\frac{1}{2}\times 6.1\times 3.8\times \sin P = 9$ **or** (area $PQRS$ =) $6.1\times 3.8\times \sin P = 18$	$\frac{1}{2}\times 6.1\times SX = 9$ **or** $(SX =)\frac{9}{\frac{1}{2}\times 6.1}(=2.95...)$ **or** $6.1\times SX = 18$ **or** $(SX =)18\div 6.1(=2.95...)$		5	M1 correct equation for the area of the triangle or parallelogram **or** a calculation to find the height of the parallelogram (where X is the point vertically below S on PQ)
	eg (sin P =) $\frac{9}{\frac{1}{2}\times 6.1\times 3.8}\left(=0.776... \text{ or } \frac{900}{1159}\right)$ **or** (sin P =) $\frac{18}{6.1\times 3.8}\left(=0.776... \text{ or } \frac{900}{1159}\right)$	$(PX^2 =)3.8^2-"2.95..."^2(=5.73...)$ **or** $(PX =)\sqrt{3.8^2-"2.95..."^2}(=2.39...)$			M1 correct expression for sin P **OR** for start of Pythagoras method to find length of PX (where X is the point vertically below S on PQ)
	$(P =)\ \sin^{-1}"0.776..."\ (=50.9...)$	$(QX =)6.1-\sqrt{"5.73"}(=3.70...)$ **or** $(QX =)6.1-"2.39"(=3.70...)$			M1 for complete method to find angle P **OR** for method to find length of QX
	$(QS^2 =)3.8^2+6.1^2-2\times 3.8\times 6.1\times\cos("50.9")(=22.4...)$ **or** $(QS =)\sqrt{3.8^2+6.1^2-2\times 3.8\times 6.1\times\cos("50.9")}$	$(QS^2 =)"2.95..."^2+"3.70..."^2(=22.4...)$ **or** $(QS =)\sqrt{"2.95..."^2+"3.70..."^2}$			M1 correct expression for QS^2 (or QS)
			4.74		A1 accept 4.73 − 4.74
					Total 5 marks

16	$\frac{\sin ABC}{24} = \frac{\sin 64}{31}$ oe		5	M1
	$(ABC =)\sin^{-1}\left(\frac{24\times\sin 64}{31}\right)(= 44.\ldots)$			M1
	180 – "44.…" – 64 (= 71.9…)			M1 accept 72
	$(DE^2 =)16^2+19^2-2\times16\times19\times\cos"71.9..."$ or $(DE =)\sqrt{16^2+19^2-2\times16\times19\times\cos"71.9..."}$ or $(DE =)\sqrt{617-181.8...}$ or $\sqrt{428.166...}$			M1 for DE^2 or DE
	Correct answer scores full marks (unless from obvious incorrect working)	20.7		A1 awrt 20.7
				Total 5 marks

17	$12 = \frac{1}{2} \times 4.6 \times 8.3 \times \sin ABC$ or $\frac{4.6h}{2} = 12$ $(h = 5.217....)$		5	M1	a correct equation for the area to find angle *ABC* or to find the perpendicular height of the triangle.
	$ABC = \sin^{-1}\left(\frac{12}{\frac{1}{2} \times 4.6 \times 8.3}\right)$ (= 38.947…) oe or $ABC = \sin^{-1}(0.6286)$ (= 38.947...) or $ABC = \sin^{-1}\left(\frac{"5.217..."}{8.3}\right)$ (= 38.947...) or $BM^2 = 8.3^2 - "5.217..."^2$			M1	A correct method to find angle *ABC* or a correct method to find BM^2 where *CMB* is 90º
	$AC^2 = 4.6^2 + 8.3^2 - 2 \times 4.6 \times 8.3 \times \cos("38.947")$ [allow cos39º] or $AC^2 = 30.6(627...)$ $BM = \sqrt{8.3^2 - "5.217..."^2}$ (=6.455…)			M1	a correct start to the cosine rule to find length AC or a fully correct method for *BM*
	or $AC = \sqrt{"30.6(6...)"}$ **or** 5.5(3739…)			A1	A correct value for *AC* which can be the square root of 30.6(6…)
	Correct answer scores full marks (unless from obvious incorrect working)	18.4		A1	Allow answers in range 18.4 to 18.45
					Total 5 marks

10	$\tan 40 = \frac{8}{(AD)}$ or $\frac{(AD)}{\sin(90-40)} = \frac{8}{\sin 40}$ oe or $(AC =) \frac{8}{\sin 40} (= 12.4(457\ldots)$ (D = foot of the perpendicular line)		5	M1
	$(AD =) \frac{8}{\tan 40}$ $(= 9.5(3\ldots))$ or $(AD =) \frac{8}{\sin 40} \times \sin(90-40)$ $(= 9.5(3\ldots))$ oe or $(AD =) \sqrt{"12.4"^2 - 8^2} = \sqrt{90.8(977...)}$ $(= 9.5(3\ldots))$ oe or $(BC^2 =) "12.4"^2 + 22^2 - 2 \times "12.4" \times 22 \times \cos 40 (= 219.4\ldots)$ oe			M1
	$(DB =) 22 - "9.5(3\ldots)"$ $(= 12.4(659\ldots = 12.5)$ or $(BC =) \sqrt{"12.4"^2 + 22^2 - 2 \times "12.4" \times 22 \times \cos 40}$ $(= \sqrt{219.4...} = 14.8)$ oe or $(BC =) \sqrt{8^2 + (22 - 9.5(3...))^2}$ $(= 14.8)$ oe			M1
	$\tan x = \frac{8}{"12.5"}$ or $\cos x = \frac{"12.5"}{"14.8"}$ or $\sin x = \frac{8}{"14.8"} (\times \sin 90)$ oe or $\sin x = \frac{\sin 40}{"14.8"} \times "12.4"$ oe or $\cos x = \frac{22^2 + "14.8"^2 - "12.4"^2}{2 \times 22 \times "14.8"}$ oe			M1
	Working required	32.7		A1 Allow 32.3 – 32.8 dep on a correct method shown
				Total 5 marks

19	$\frac{(BD)}{\sin 62} = \frac{12.8}{\sin 40}$ oe or		5	M1 for correct use of sine rule for *BD*	M2 for $(CD =) \frac{12.8}{\sin 40} \times \sin 78$ $(= 19.4(781\ldots))$ **and** $(BD =) \frac{"19.4(781...)"}{\sin 78} \times \sin 62$ $(= 17.5(82\ldots))$
	$(BD =) \frac{12.8}{\sin 40} \times \sin 62 (= 17.5(82\ldots))$			M1 for finding *BD* (truncated or rounded)	
	$"17.5(82...)"^2 = 13.4^2 + 15.2^2 - 2 \times 13.4 \times 15.2 \times \cos x$ or $309(.139) = 179(.56) + 231(.04) - 407(.36)\cos x$ oe			M1 for correct use of cosine rule	
	$(\cos x =) \frac{13.4^2 + 15.2^2 - "17.5(82...)"^2}{2 \times 13.4 \times 15.2}$ oe or $(\cos x =) \frac{179(.56) + 231(.04) - 309(.139...)}{407(.36)}$ oe or $(\cos x =) \frac{410(.6) - 309(.139...)}{407(.36)}$ oe or $(\cos x =) 0.247 - 0.256$ oe			M1 for a correct rearrangement of cos *x*	
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	75.6		A1 accept 75.1 – 75.7	
					Total 5 marks

20	$(BD^2 =) 9.4^2 + 12.8^2 - 2\times 9.4\times 12.8\times \cos 72$ (= 177.8…) **or** $(BD^2 =) 88.36 + 163.84 - 2\times 9.4\times 12.8\times \cos 72$ (=177.8…) oe **or** $(BD =) \sqrt{9.4^2 + 12.8^2 - 2\times 9.4\times 12.8\times \cos 72}$		5	M1	for applying cosine rule
		(*BD* =)13.3		A1	allow 13.3 – 13.342 or $\sqrt{177.8...}$ or $\sqrt{178}$
	eg $\frac{BC}{\sin 39} = \frac{"13.3..."}{\sin 54}$ **or** $\frac{\sin 39}{BC} = \frac{\sin 54}{"13.3..."}$			M1ft	for applying the sine rule, allow use of their *BD*
	$(BC =) \frac{"13.3..."}{\sin 54} \times \sin 39$			M1ft	for method to find *BC* using the sine rule allow use of their *BD*
	Correct answer scores full marks (unless from obvious incorrect working)	10.4		A1	allow 10.3 – 10.4
					Total 5 marks

18	$SQ^2 = 8^2 + 12^2 - 2\times8\times12\times\cos120^o$	91.4	6	M1	If this mark is awarded then ft on the remaining M marks
	$(SQ) = \sqrt{304}$			M1	for correct order of operations e.g. 64 + 144 + 96 or 304 or 17.4…. or $4\sqrt{19}$
	$\frac{\sin R}{\text{"}\sqrt{304}\text{"}} = \frac{\sin 27^\circ}{9}$			M1	
	$R = sin^{-1}\left(\frac{\sin 27^\circ \times \text{"}\sqrt{304}\text{"}}{9}\right)$			M1	can be implied by 61.5833...
	61.58			A1	for 61.58 - 61.6
				B1	ft dep M3 180 – "61.6" – 27
					Total 6 marks

19	$\frac{dy}{dx} = 3x^2 - 27$	108		M1	for at least one of $3x^2$ or 27
	$3x^2 - 27 = 0$			M1	(dep) for a 2 or 3 term quadratic =0
	$x = \pm3$			A1	
	When $x = -3$, $b = (-3)^3 - 27(-3) + k$ (= 54 + k) When $x = 3$, $d = 3^3 - 27(3) + k$ (= −54 + k)			M1	for either substituting $x = 3$ or $x = -3$ into the y expression. Only award this mark if k or a number representing k is in the expression for b or d
	$b - d = 54 + k - (-54 + k)$			M1	dep on all previous M marks Expressions for b and d must have k or the same number representing k
				A1	
					Total 6 marks

19		250 = 0.5 × 26 × *AC* × sin(39) oe			M1 for using the area formula correctly If this mark is awarded then ft on the remaining M marks
		(*AC*=) 30.5(5579...) or 30.6			A1
		$\frac{(AB)}{\sin 47} = \frac{'30.56'}{\sin 95}$ oe **or** $\frac{(BC)}{\sin(180-95-47)} = \frac{'30.56'}{\sin 95}$ oe			M1 dep on M1 for correct substitution into sine rule
		$(AB =) \frac{'30.56'}{\sin 95} \times \sin 47$ (= 22.4(3407...)) **or** $(BC =) \frac{'30.56'}{\sin 95} \times \sin(180-95-47)$ (= 18.8(8524...))			M1 (dep on previous M marks) for a correct method to find a missing length **or** sight of values in the ranges 22.39 – 22.47 for *AB* 18.8 – 18.92 for *BC*
		250 + 0.5 × '30.56' × '22.43' × sin(180 – 95 – 47) (= 461.03....) **or** 250 + 0.5 × '30.56' × '18.88' × sin(47) (= 461.03....)			M1 for a complete method to find total area
			461	6	A1 accept 461 - 462
					Total 6 marks

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

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

Question	Working	Answer	Mark	Notes
18	[*ADC* =] 180 – 98 (= 82)		6	M1 may be seen on diagram
	$[AC^2 =] 8^2 + 7.5^2 - 2\times 8\times 7.5\times\cos(98) (=136.95...)$			M1 correct equation for *AC* or AC^2
	$[AC =]\sqrt{"136.95"}$ **or** $\sqrt{64+56.25+16.7....} (=11.7...)$ oe			M1 complete method to find *AC* showing correct order of operations
	eg $[[AD =]\frac{"11.7"\sin 35}{\sin"82"} (=6.77..)$ **or** $[DC =]\frac{"11.7"\times\sin"63"}{\sin"82"} (=10.5..)$oe (where **"82" = 180 – 98** , "63" = 180 – "82" – 35)			M1 correct calculation for *AD* **or** *DC* dep on 1st M1 and 2nd M1
	eg $[AD =]\frac{"11.7"\sin 35}{\sin"82"}$ **and** $[DC =]\frac{"11.7"\sin"63"}{\sin"82"}$ oe **or** $[AD =]\frac{"11.7"\sin 35}{\sin"82"}$ **and** $[DC =]\sqrt{"11.7"^2+"6.77"^2-2\times"11.7"\times"6.77"\times\cos"63"}$ $[DC =]\frac{"11.7"\sin"63"}{\sin"82"}$ **and** $[AD =]\sqrt{"11.7"^2+"10.5"^2-2\times"11.7"\times"10.5"\times\cos 35}$ Where "63" = 180 – "82" – 35			M1 correct calculations for *AD* **and** *DC* (*AD* = 6.77... *DC* = 10.5...) dep on 1st M1 and 2nd M1
	Working not required, so correct answer scores full marks (unless from obvious incorrect working)	32.8		A1 accept 32.7 – 32.9
				Total 6 marks

23	$\frac{\sin Q}{4.2} = \frac{\sin 18}{1.6}$ oe or $1.6^2 = 4.2^2 + RQ^2 - 2\times 4.2\times RQ\times\cos 18$ oe		6	M1 correct sine ratio - could be rearranged or correct substitution into the cosine rule using angle R
	$\sin^{-1}\left(4.2\times\frac{\sin 18}{1.6}\right)$ (= 54.2) **or** $\sin^{-1}(0.811...)$ $\frac{2\times 4.2\times\cos 18 \pm \sqrt{(2\times 4.2\times\cos 18)^2 - 4\times 1\times 15.08}}{2}$			M1
	180 – "54.2" (=125.8) or RQ = 3.0585.. and 4.933…			M1 This can be implied by the correct value(s) (125.8 or 3.0585…) used later
	(P =) 180 –"125.8" – 18 (=36.2) **or** $RQ = \sqrt{4.2^2 + 1.6^2 - 2\times 4.2\times 1.6\times\cos"36.2"}$ (= 3.0585…) or 3.0585 chosen as value from cosine rule above **or** perpendicular height = 4.2sin"36.2" (= 2.4805…) (where "36.2" comes from correct working)			M1
	(Area =) $\frac{1}{2}\times 4.2\times 1.6\times\sin("36.2")$ **or** (Area =) $\frac{1}{2}\times 4.2\times"3.0585..."\times\sin 18$ **or** (Area =) $\frac{1}{2}\times 1.6\times"2.4805..."$			M1
		1.98		A1 awrt 1.98
				Total 6 marks

25	eg $\frac{1}{2}(2x-1)(2x+1)\sin 30 = x^2 + x - 3.75$ oe		6	M1	for equating area of triangle with the given area
		3.5		A1	for the value of x
	$(BC^2 =)$ "6"^{2} + "8"^{2} − (2 × "6" × "8" × cos 30) (= 16.8(615...)) oe or (BC =) $\sqrt{\text{"16.8..."}}$ (= 4.10(628…))			M1	ft dep on M1 for a correct method to find BC^2 or BC (AB = 6 and AC = 8)
	$\frac{\sin(ABC)}{\text{"8"}} = \frac{\sin 30}{\sqrt{\text{"16.8"}}}$ oe or $\frac{\sin(BCA)}{\text{"6"}} = \frac{\sin 30}{\sqrt{\text{"16.8"}}}$ oe or $\text{"6"}^2 = \text{"8"}^2 + \left(\sqrt{\text{"16.8"}}\right)^2 - \left(2 \times \text{"8"} \times \sqrt{\text{"16.8"}} \times \cos(BCA)\right)$ oe or $\text{"8"}^2 = \text{"6"}^2 + \left(\sqrt{\text{"16.8"}}\right)^2 - \left(2 \times \text{"6"} \times \sqrt{\text{"16.8"}} \times \cos(ABC)\right)$ oe			M1	ft dep on previous M1 for a correct method to find angle ABC or angle BCA
	$(\sin ABC =) \frac{\sin 30 \times \text{"8"}}{\sqrt{\text{"16.8"}}} (= 0.974...)$ oe or ABC = 76.9… or $(\sin BCA =) \frac{\sin 30 \times \text{"6"}}{\sqrt{\text{"16.8"}}} (= 0.730...)$ oe or BCA = 46.9… or $(\cos BCA =) \frac{\text{"8"}^2 + \left(\sqrt{\text{"16.8"}}\right)^2 - \text{"6"}^2}{2 \times \text{"8"} \times \left(\sqrt{\text{"16.8"}}\right)} (= 0.682...)$ oe or BCA = 46.9… or $(\cos ABC =) \frac{\text{"6"}^2 + \left(\sqrt{\text{"16.8"}}\right)^2 - \text{"8"}^2}{2 \times \text{"6"} \times \left(\sqrt{\text{"16.8"}}\right)} (= -0.226...)$ oe or ABC = 103.0…			M1	ft dep on previous M1 for a correct rearrangement for sin ABC or sin BCA or cos BCA or cos ABC
	Correct answer scores full marks (unless from obvious incorrect working)	103		A1	accept awrt 103
					Total 6 marks

21		e.g. (*AC* =) $\sqrt{(4x)^2 + (2x)^2}$ (= $\sqrt{20}x$) **or** (*AC* =) $\sqrt{(4)^2 + (2)^2}$ (= $\sqrt{20}$) **or** (*AF* =) $\sqrt{(4)^2 + (2)^2 + (3)^2}$ (= $\sqrt{29}$) **or** (*AF* =) $\sqrt{(\sqrt{20})^2 + (3)^2}$ (= $\sqrt{29}$) **or**			M1 for a method to find an expression for length *AC* or length *AF* with or without *x* **or** *x* can represent any number e.g. *AB* : *BC* : *CF* = 2 : 1 : 1.5 $AC^2 = \sqrt{2^2 + 1^2}\left(= \sqrt{5}\right)$
		e.g. (*CAF* =) $\tan^{-1}\left(\frac{3x}{'\sqrt{20x}'}\right)$ (= 33.854...) or (*CAF* =) $\tan^{-1}\left(\frac{3}{'\sqrt{20}'}\right)$ (= 33.854...) or (*CAF* =) $\cos^{-1}\left(\frac{'\sqrt{20}'}{'\sqrt{29}'}\right)$ (= 33.854...) or (*CAF* =) $\sin^{-1}\left(\frac{3}{'\sqrt{29}'}\right)$ (= 33.854...)			M1 for a complete method to find angle *CAF* using length *AC* **or** for a complete method to find angle *CAF* using length *AF* with or without *x* or *x* can represent any number *AB* : *BC* : *CF* = 2 : 1 : 1.5 (*CAF* =) $\tan^{-1}\left(\frac{1.5}{'\sqrt{5}'}\right)$ (= 33.854...)
			33.9°	3	A1 answers in the range 33.85 – 33.9
					Total 3 marks

19	$(AC =)\ \sqrt{8^2+18^2}\ \left(=\sqrt{388}=2\sqrt{97}=19.697...\right)$ **or** $(CE =)\ \sqrt{8^2+18^2+12^2}\ \left(=\sqrt{532}=2\sqrt{133}=23.065...\right)$ oe		3	M1
	eg $\tan ECA = \left(\dfrac{12}{\sqrt{388}}\right)$ **or** $\sin ECA = \left(\dfrac{12}{\sqrt{532}}\right)$ **or** $\cos ECA = \left(\dfrac{\sqrt{388}}{\sqrt{532}}\right)$ **or** $\sin ECA = \dfrac{\sin 90 \times 12}{\sqrt{532}}$ **or** $\cos ECA = \left(\dfrac{(\sqrt{388})^2+(\sqrt{532})^2-12^2}{2\times\sqrt{388}\times\sqrt{532}}\right)$ oe			M1 for a correct trig statement with *ECA* as the only unknown. NB allow use 'x' or other variable in place of *ECA*.
		31.4		A1 allow 31.3 – 31.5
				Total 3 marks

23		eg (*CE* =) $40 \times \tan 35$ (= 28(.0…)) **or** (*CE* =) $\frac{40}{\tan(90 - 35)}$ (= 28(.0…)) **or** (*CE* =) $\frac{40\sin 35}{\sin(90 - 35)}$ (= 28(.0…))		3	M1	for a correct method to find *CE*
		eg (angle *CME* =) $\tan^{-1}\left(\frac{"28"}{40\ ,\ 2}\right)$ **or** (angle *CME* =) $\sin^{-1}\left(\frac{"28"}{\sqrt{(40\ ,\ 2)^2 + "28"^2}}\right)$ **or** (angle *CME* =) $\cos^{-1}\left(\frac{40\ ,\ 2}{\sqrt{(40\ ,\ 2)^2 + "28"^2}}\right)$			M1	for a complete method to find angle *CME*
		Correct answer only scores full marks (unless from obviously incorrect working)	54.5		A1	awrt 54.5
						Total 3 marks

19		$(AH =)\sqrt{6^2+5^2+9^2}$ $(=\sqrt{142}\ )$ **or** $(FH = GE =)\ \sqrt{5^2+9^2}$ $(=\sqrt{106}\ )$		4	M1 for working out *AH* or *FH* or *GE*
		E.g. $\sin AHF = \frac{6}{'\sqrt{142}'}$ **or** $\tan AHF = \frac{6}{'\sqrt{106}'}$ **or** $\cos AHF = \frac{'\sqrt{106}'}{'\sqrt{142}'}$ **or** $\sin FAH = \frac{'\sqrt{106}'}{'\sqrt{142}'}$ **or** $\cos FAH = \frac{6}{'\sqrt{142}'}$ **or** $\tan FAH = \frac{'\sqrt{106}'}{6}$			M1 for a correct method for finding angle *AHF* **or** finding angle *FAH* Allow $\cos AHF = \left(\frac{'\sqrt{142}'^2+'\sqrt{106}'^2-6^2}{2\times'\sqrt{142}'\times'\sqrt{106}'}\right)$ oe **or** $\sin AHF = \frac{\sin 90}{'\sqrt{142}'}\times 6$ oe
		E.g. $\sin^{-1}\left(\frac{6}{'\sqrt{142}'}\right)$ **or** $\tan^{-1}\left(\frac{6}{'\sqrt{106}'}\right)$ **or** $\cos^{-1}\left(\frac{'\sqrt{106}'}{'\sqrt{142}'}\right)$ **or** $90-\sin^{-1}\left(\frac{'\sqrt{106}'}{'\sqrt{142}'}\right)$ **or** $90-\cos^{-1}\left(\frac{6}{'\sqrt{142}'}\right)$ **or** $90-\tan^{-1}\left(\frac{'\sqrt{106}'}{6}\right)$			M1 for a complete method Allow $\cos^{-1}\left(\frac{'\sqrt{142}'^2+'\sqrt{106}'^2-6^2}{2\times'\sqrt{142}'\times'\sqrt{106}'}\right)$ oe **or** $\sin^{-1}\left(\frac{\sin 90}{'\sqrt{142}'}\times 6\right)$ oe
			30.2		A1 for 30.2 – 30.3
					Total 4 marks

22	$\sin\left(\frac{180-140}{2}\right)=\frac{MB}{8}$ oe or $\cos\left(\frac{140}{2}\right)=\frac{MB}{8}$ oe **or** $\frac{8}{\sin 20}=\frac{AC}{\sin 140}$ **and** $(MB^2)=8^2-\left(\frac{"15.035"}{2}\right)^2$ **or** $AC=\sqrt{8^2+8^2-2\times8\times8\times\cos140}$ (=15.035…) **and** $(MB^2)=8^2-\left(\frac{"15.035"}{2}\right)^2$		4	M1	for a correct expression with *MB* included, or an expression for MB^2 If using sine or cosine rule on the isosceles triangle *ABC*, use of Pythagoras required to obtain an expression for MB^2
	(*MB* =) 8sin(“20”) (= 2.736) or (*MB* =) 8cos(“70”) (= 2.736) or $(MB)=\sqrt{8^2-\left(\frac{"15.035"}{2}\right)^2}$			M1	
	$\tan TMB=\frac{10}{"2.736"}$			M1	dep 1st M1
		74.7		A1	74.65 to 74.75
					Total 4 marks
					TOTAL FOR PAPER 100 MARKS

22		$[AM =]\sqrt{5^2+15^2}\,(=\sqrt{250}=15.8...)$ where M is midpoint of EF, oe other correct method to find AM $[AD =]\sqrt{12^2+15^2}\,(=\sqrt{369}=19.2...)$ $[DM =])\sqrt{12^2-5^2}\,(=\sqrt{119}=10.9...)$		4	M2	for a complete method to find **two** of AM, AD, DM (where M is the midpoint of EF) Other longer ways to find AM, AD, DM may be used but must be a complete method eg $\angle DEM=\cos^{-1}(\frac{5}{12})(=65.37...)$ **and** $DM=12\sin 65.37...$ $\angle DEM=\cos^{-1}(\frac{5}{12})(=65.37...)$ **and** $DM=5\tan 65.37...$ Use $10 \div 2$ as 5 throughout (M1 For a complete method to find **one** of AM, AD, DM (where M is the midpoint of EF))
		eg tan $DAM = \frac{"\sqrt{119}"}{"\sqrt{250}"}\left(=\frac{"10.9..."}{"15.8..."}\right)$ oe **or** sin $DAM = \frac{"\sqrt{119}"}{"\sqrt{369}"}\left(=\frac{"10.9..."}{"19.2..."}\right)$ oe **or** cos $DAM = \frac{"\sqrt{250}"}{"\sqrt{369}"}\left(=\frac{"15.8..."}{"19.2..."}\right)$ oe			M1	a correct method to find the required angle –other longer methods may be used but they must get to the stage of an equation for the required angle eg $\sin DAM = \frac{"10.9..."}{\sqrt{"15.8..."^2+"10.9..."^2}}$ NB: "10.9…" and "15.8…" must come from correct working
		Working not required, so correct answer scores full marks (unless from obvious incorrect working)	34.6		A1	any answer which rounds to 34.6
						Total 4 marks

18	eg $(BV^2 =)3^2+6^2(=45)$ **or** $(CT^2 =)3^2+6^2(=45)$ **or** $(DH^2 =)\ 6^2+6^2\ (=72)$ **or** $(MV^2 =)3^2+3^2(=18)$		4	M1 a correct expression for eg BV^2 **or** CT^2 **or** DH^2 **or** MV^2 where M is the midpoint of DC **or** a correct expression for [length]^2 for any length in the cube using Pythagoras	M3 for $(VT =)\sqrt{6^2+3^2+3^2}$ $(=3\sqrt{6}$ or 7.34...) (M2 for $(VT^2 =)$ $6^2+3^2+3^2\ (=54)$)
	eg $(BV =)\sqrt{3^2+6^2}\ (=\sqrt{45}$ or $3\sqrt{5}$ or 6.70...) **or** $(CT =)\sqrt{3^2+6^2}\ (=\sqrt{45}$ or $3\sqrt{5}$ or 6.70...) **or** $(DH =)\sqrt{6^2+6^2}\ (=\sqrt{72}$ or $6\sqrt{2}$ or 8.48...) **or** $(MV =)\sqrt{3^2+3^2}\ (=\sqrt{18}$ or $3\sqrt{2}$ or 4.24...)			M1 for a complete method for eg BV **or** CT **or** DH **or** MV **or** any length in the cube using Pythagoras	
	$(VT =)\ \sqrt{"45"+3^2}$ **or** $\sqrt{\left(\frac{"\sqrt{72}"}{2}\right)^2+6^2}$ **or** $\sqrt{"18"+6^2}$ **or** $3\sqrt{6}$ **or** 7.34...			M1 for a correct expression for VT (condone missing brackets around $3\sqrt{5}$ or $3\sqrt{2}$ or $\frac{\sqrt{72}}{2}$)	
		$\sqrt{54}$		A1 if $\sqrt{54}$ seen and answer then given as $3\sqrt{6}$ isw and award full marks	
					Total 4 marks

20		(a =) 2 (b =) 135	2	B2	If not B2, then B1 for one correct value
					Total 2 marks

21	$(AD=)\dfrac{2.2}{\tan 18}$ (= 6.77...) or $(EA=)\dfrac{2.2}{\sin 18}(=7.11...)$		4	M1	a correct method to find AD or AE
	$(DB=)\sqrt{("6.77...")^2+6^2}$ (= 9.04...) or $(EB=)\sqrt{6^2+"7.11..."^2}$ (= 9.31...) or $(EB=)\sqrt{6^2+"6.77..."^2+2.2^2}(=9.31...)$			M1	a correct method to find DB or EB
	$\tan DBE=\dfrac{2.2}{"9.04..."}$ or $\sin DBE=\dfrac{2.2}{"9.31..."}$ or $\sin DBE=\dfrac{2.2\sin 90}{"9.31..."}$ $\cos DBE=\dfrac{"9.04..."}{"9.31..."}$ or use of cosine rule			M1	complete method to find one of tanDBE or sinDBE or cosDBE– NB: if using cosine, the student will need to have found DB and EB previously
	Correct answer scores full marks (unless from obvious incorrect working)	13.7		A1	Allow answers in range 13.59 – 13.8
					Total 4 marks

Question	Working			Answer	Mark	Notes
24	**To find *EQ*** eg $MQ = 0.5\ (= AQ)$ $\frac{0.5}{\cos 80}(= 2.87(938..))$ eg $MQ = x\ (= AQ)$ $\frac{x}{\cos 80}(= 5.75..x)$ NB cos80 = sin10	**To find *EM*** eg $MQ = 0.5\ (= AQ)$ $0.5\tan 80(= 2.83(564..))$ eg $MQ = x\ (= AQ)$ $x\tan 80(= 5.67..x)$ NB $\tan 80 = \frac{1}{\tan 10}$	**To find *EQ*** eg $EM = y$ $\frac{y}{\sin 80}(= 1.01..y)$ **To find *MQ* (= *AQ*)** eg $EQ = h$ $h\cos 80(= 0.173..h)$		4	M1 Use of a value for the side *AB* eg 1 or 2*x* or any value etc or Let *EM* = *y* or any value or *EQ* = *h*
	To find *EA*² eg $AQ = 0.5\ (= MQ)$ $"2.87.."^2 + 0.5^2$ $(= 8.54(08..))$ eg $AQ = x\ (= MQ)$ $x^2 + "\left(\frac{x}{\cos 80}\right)"^2$	**To find *AM*** eg $MQ = 0.5\ (= AQ)$ $\sqrt{0.5^2 + 0.5^2}$ $\left(= \frac{\sqrt{2}}{2} = 0.707(10..)\right)$ eg $MQ = x\ (= AQ)$ $\sqrt{x^2 + x^2}\left(= \sqrt{2x^2} = x\sqrt{2}\right)$	**To find *MQ* (= *AQ*)** eg $EM = y$ $\frac{y}{\tan 80}(= 0.176..y)$ **To find *EA*²** eg $EQ = h$ $h^2 + "(h\cos 80)"^2$			M1
	To find *EA* eg $AQ = 0.5\ (= MQ)$ $\sqrt{"2.87.."^2 + 0.5^2}$ $\left(= \sqrt{8.54(08..)}\right)$ or eg $AQ = x\ (= MQ)$ $\sqrt{x^2 + "\left(\frac{x}{\cos 80}\right)"^2}\ (= 5.84..x)$	**To find *EA*** eg $AQ = 0.5\ (= MQ)$ $\sqrt{"2.83.."^2 + "0.707.."^2}$ $\left(= \sqrt{8.54(08..)}\right)$ eg $AQ = x\ (= MQ)$ $\sqrt{"(x\tan 80)"^2 + "\left(x\sqrt{2}\right)"^2}$ $(= 5.84..x)$	**To find *EA*** eg $EM = y$ $\sqrt{"\left(\frac{1}{\sin 80}\right)"^2 + "\left(\frac{1}{\tan 80}\right)"^2}$ $(= 1.03..y)$ [= 1.03.. × *AQ* × tan80] eg $EQ = h$ $\sqrt{h^2 + "(h\cos 80)"^2}\ (= 1.01..h)$ $[= 1.01.. \times \frac{0.5}{\cos 80}]$			M1
Working not required, so correct answer scores full marks (unless from obvious incorrect working)				2.92		A1 awrt 2.92
						Total 4 marks

18	eg $\frac{4}{AC} = \tan 35$ oe **or** $\frac{AC}{4} = \tan 55$ oe **or** $\frac{AC}{\sin 55} = \frac{4}{\sin 35}$ oe **or** $CH = \frac{4}{\sin 35}$ oe (= 6.97...) **and** $\frac{AC}{"6.97"} = \cos 35$ oe **or** $CH = \frac{4}{\sin 35}$ oe (=6.97...) **and** $AC^2 = 6.97^2 - 4^2$ oe			M1 A correct trig statement involving *AC* **or** trig and then Pythagoras involving *AC*
	$(AC =) \frac{4}{\tan 35}$ oe eg $(AC =)$ 4tan55 (= 5.71...) **or** $(AC =) \frac{4\sin 55}{\sin 35}$ **or** "6.97" × cos35 oe **or** $(AC =) \sqrt{"6.97"^2 - 4^2}$			M1 complete method to find *AC*
	$(BC =) \sqrt{"5.71"^2 - 5^2}$ (= 2.76...)			M1 complete method to find *BC*
	4 × 5 × "2.76..."			M1 method to find volume
		55.3	5	A1 accept 55.1 – 55.5
				Total 5 marks

21	eg $(AM =)\sqrt{x^2+(4x)^2}\ (=\sqrt{17x^2}=x\sqrt{17})$ oe **or** $(AM =)\sqrt{(0.5x)^2+(2x)^2}\left(=\sqrt{\frac{17}{4}}x^2=x\frac{\sqrt{17}}{2}\right)$ oe **or** $(AM =)\sqrt{20^2+5^2}\ (=\sqrt{425}=5\sqrt{17})$ oe		5	M1 for a correct method to find *AM* as a numerical value or in algebraic form, must have brackets or recover
	Height of triangle eg $\sqrt{(2x)^2-x^2}\ (=\sqrt{3x^2}=x\sqrt{3})$ oe **or** $\sqrt{x^2-(0.5x)^2}\left(=\sqrt{\frac{3}{4}}x^2=x\frac{\sqrt{3}}{2}\right)$ oe **or** $\sqrt{10^2-5^2}\ (=\sqrt{75}=5\sqrt{3})$ oe			M1 for a correct method to find height of equilateral triangle *HJK* as a numerical value or in algebraic form
	eg $\tan MAJ=\frac{\sqrt{3}+2}{\sqrt{17}}$ **or** $\tan MAJ=\frac{\frac{\sqrt{3}}{2}+1}{\frac{\sqrt{17}}{2}}$ **or** $\tan MAJ=\frac{5\sqrt{3}+10}{5\sqrt{17}}$			M1 for correct values for the correct angle (no algebra) **or** for tan *MAJ* is given numerically in the range 0.9 – 0.91
	eg $\frac{(\sqrt{3}+2)}{\sqrt{17}}\times\frac{\sqrt{17}}{\sqrt{17}}\left(=\frac{\sqrt{51}+2\sqrt{17}}{17}\right)$			M1
		$\frac{\sqrt{68}+\sqrt{51}}{17}$		A1 or $\frac{\sqrt{51}+\sqrt{68}}{17}$
				Total 5 marks

22	$9^2 = 11^2 + 16^2 - 2 \times 11 \times 16 \times \cos BCA$ oe or $11^2 = 9^2 + 16^2 - 2\times 9\times 16\times \cos BAC$ or $16^2 = 9^2 + 11^2 - 2\times 9\times 11\times \cos ABC$ or (area of $\triangle ABC =)\sqrt{18\times 2\times 7\times 9} (= 47.6235...)$ oe		5	M1 For a start to the correct method to find angle *BCA* or angle *BAC* or angle *ABC* or a fully correct method to find the area of the triangle
	$(\cos BCA =)\left(\frac{11^2+16^2-9^2}{2\times 11\times 16}\right) (BCA = 32.763...)$ or $(\cos BAC =)\left(\frac{9^2+16^2-11^2}{2\times 9\times 16}\right) (BAC = 41.409...)$ or $(\cos ABC =)\left(\frac{9^2+11^2-16^2}{2\times 9\times 11}\right) (ABC = 105.826...)$ or $\frac{1}{2}\times 16\times BD = "47.6235..."$			M1 For a correct rearrangement for cos*BCA* or cos*BAC* or cos*ABC* or a correct equation to find *BD* (accept angles to the nearest whole number rounded or truncated as long as not from incorrect working)
	(*BD* =) 11 sin"32.763..."(= 5.95...) oe eg 11 sin(180 – "41.4…" – 105.8…") (= 5.95…) or 9 sin"41.4…." (= 5.95…) oe or $\frac{"47.6235..."\times 2}{16} (=5.95...)$ oe or $\sqrt{11^2 - "9.25"^2}$ or $\sqrt{9^2 - "6.75"^2}$ $11\sin\left(\sin^{-1}\left(\frac{9\sin"105.826..."}{16}\right)\right)$ (= 5.95…) oe			M1 For a correct calculation that will lead to the value of *BD* "47.6235…" may also come from 0.5 × 9 × 11 × sin"105.8…" or 0.5 × 9 × 16 × sin"41.4…" or 0.5 × 16 × 11 × sin"32.7…" [Students may find an angle by sine rule after already finding an angle and use this]
	$\tan FDB = \frac{10}{"5.95..."}$ oe			M1 For a correct expression for the required angle (in form tan*x* =… or cos*x* =… or sin*x* =…) oe
	Correct answer scores full marks (unless from obvious incorrect working)	59.2		A1 awrt 59.2
	SEE OVER FOR ALTERNATIVE SCHEME			**Total 5 marks**

Angle $DBC = 57.237\ldots$ Angle $ABD = 48.591\ldots$ $AD = 6.75$ m $CD = 9.25$ m

22	$BD^2 = 11^2 - (16-y)^2$ and $BD^2 = 9^2 - y^2$ oe		5	M1	For 2 different expressions in the same single variable for BD or BD^2
	$11^2 - (16-y)^2 = 9^2 - y^2$ ($y = 6.75$ or $x = 9.25$)			M1	Equating the 2 expressions
	$BD = \sqrt{9^2 - (16-"9.25")^2}$ or $\sqrt{11^2 - "9.25"^2}$ ($=5.95$)			M1	A correct calculation to find BD ("9.25" or "6.75" must come from a correct method)
	$\tan FDB = \frac{10}{"5.95..."}$ oe			M1	For a correct expression for the required angle (in form tan$x$ =… or cos$x$ =… of sin$x$ =…) oe
	Correct answer scores full marks (unless from obvious incorrect working)	59.2		A1	awrt 59.2
					Total 5 marks

22	(a)	$\sqrt{4^2+9^2+15^2}\left(=\sqrt{322}=17.9(443...)\right)$ or $\sqrt{15^2+4^2}\left(=\sqrt{241}=15.5(241...)\right)$ **and** $\sqrt{9^2+\left("\sqrt{241}"\right)^2}\left(=\sqrt{322}=17.9(443...)\right)$		2	M1
			17.9		A1 awrt 17.9
	(b)	$(UR=)42\tan 30\,(=14\sqrt{3}=24.2(487\ldots))$ or $(UR=)\dfrac{42\times\sin 30}{\sin(90-30)}\,(=14\sqrt{3}=24.2(487\ldots))$		3	M1
		$\tan(UMR)=\left(\dfrac{"24.248..."}{42\div 2}\right)$ or $\tan(UMR)=\left(\dfrac{"24.248..."}{21}\right)$ or $\tan(UMR)=\left(\dfrac{"14\sqrt{3}"}{21}\right)$ or $(UM=)\sqrt{\left(\dfrac{42}{2}\right)^2+\left("14\sqrt{3}"\right)^2}\left(=7\sqrt{21}=32.0(780...)\right)$ **and** $\sin(UMR)=\left(\dfrac{"14\sqrt{3}"}{"7\sqrt{21}"}\right)$ or $\cos(UMR)=\left(\dfrac{21}{"7\sqrt{21}"}\right)$			M1
		Correct answer scores full marks (unless from obvious incorrect working)	49.1		A1 awrt 49.1
					Total 5 marks

Question		Working	Answer	Mark	Notes	
23		360 = (10 x 10) + 4 x 0.5 x 10 x "h" oe h = 13			M1 A1	Finding the perpendicular height of a triangular face
		$AC = \sqrt{13^2 + 5^2}$ = (13.93 or √194) or AO = $\sqrt{13^2 - 5^2}$ = (12) or OC = ($\sqrt{10^2 + 10^2}$) ÷ 2 = (7.07 or 5√2) or EC (oe) = $\sqrt{10^2 + 10^2}$ = (14.14 or 10√2)			M2	Finding the accurate length of two sides relevant to finding correct angle. M2 for two sides found or M1 for one side. 1dp rounded or truncated.
		$tan^{-1}\left(\frac{12}{7.07}\right)$ or $cos^{-1}\left(\frac{7.07}{13.93}\right)$ or $sin^{-1}\left(\frac{12}{13.93}\right)$ or $cos^{-1}\ \left(\frac{13.93^2+7.07^2-12^2}{2 \times 13.93 \times 7.07}\right)$ or $cos^{-1}\ \left(\frac{13.93^2+14.14^2-13.93^2}{2 \times 13.93 \times 14.14}\right)$	59.5°		M1 A1	A correct trigonometric expression to find correct angle Accept $\tan\theta = \left(\frac{12}{7.0}\right)$ etc Accept 59.4° – 59.7°
						Total 6 marks

17 (a)	$(FH =)\ \sqrt{12^2+12^2}\ (=16.97...$ or $\sqrt{288}$ or $12\sqrt{2})$		3	M1	
	$\tan CFH = \frac{10}{"16.97..."}$ oe **or** e.g. $(CF =)\ \sqrt{"16.97"^2+10^2}\ (=19.69...$ or $\sqrt{388}$ or $2\sqrt{97})$ **and** e.g. $\frac{\sin CFH}{10} = \frac{\sin 90}{"19.69"}$			M1	for a correct trig statement involving *CFH*
		30.5		A1	accept 30.4 – 30.7
(b)	$(BG =)\ 10 + \sqrt{15^2-12^2}\ (=19)$		3	M1	
	$(BE =)\ \sqrt{"19"^2+"16.97..."^2}$ oe			M1	ft their *FH*
		25.5		A1	accept 25.4 – 25.6
					Total 6 marks

18	$a + 5d = 39$ **or** $a + 18d = 7.8$ **or** $13d = -31.2$ oe		4	M1
	$a = 51$ **or** $d = -2.4$			A1
	e.g. $\frac{25}{2}(2\times 51+(25-1)\times -2.4)$ oe **or** $12.5(2a + 23d + d) = 12.5(39 + 7.8 – 2.4)$ oe			M1 for substituting their values for *a* and *d* into S_n, *a* and *d* must be clearly stated.
		555		A1
				Total 4 marks

22	eg $MP = \sqrt{8^2 + 6^2}\ (= 10)$		6	M1 for a method to find *MP* may be seen in subsequent working eg in the correct place in the cosine rule 10 seen without a correct method or without being identified as *MP* scores M0
	eg $BM = \sqrt{\left(\sqrt{10^2 + 6^2}\right)^2 + 8^2}\ \left(= \sqrt{200} = 10\sqrt{2} = 14.1...\right)$			M1 for a method to find *BM*
	eg $BP = \sqrt{12^2 + 10^2}\ \left(= \sqrt{244} = 2\sqrt{61} = 15.6...\right)$			M1 for a method to find *BP*
	eg $"244" = "10"^2 + "200" - 2 \times "10" \times \sqrt{"200"} \cos BMP$ **or** $\cos BMP = \dfrac{"10"^2 + "200" - "244"}{2 \times "10" \times \sqrt{"200"}}$ oe			M1 for correct substitution into the cosine rule
	angle $BMP = \cos^{-1}\left(\dfrac{"10"^2 + "200" - "244"}{2 \times "10" \times \sqrt{"200"}}\right)$ oe			M1 for a complete correct method to find angle *BMP*
	Correct answer scores full marks (unless from obvious incorrect working)	78.6		A1 accept 78.5 − 78.7
				Total 6 marks

17	(a)	$\left(\frac{37+28}{2}\right)\times 20 (=650)$		4	M1	Correct method to find area of trapezium
		$\sqrt{4.5^2+20^2}\,(=20.5)$ oe			M1	Correct method to find slanted edge *AB* oe
		2 × '650' + 2 × '20.5' × 24 + 37 × 24 + 28 × 24 (2 × '650' + 2 × 492 + 888 + 672)			M1	method to find the sum of the surface areas of at least 4 correct faces (ft their area of trapezium) ignore incorrect areas
			3844		A1	
	(b)	eg $\sqrt{24^2+(37-"4.5")^2}\,(=40.4)$ $(AF=)\ \sqrt{24^2+20^2+(37-"4.5")^2}\ (=45.08...)$		3	M1	Correct method to find diagonal from *A* to point on *HE* below *F* **or** *AF*
		$\tan x = \frac{20}{"40.4"}$ or $\sin x = \frac{20(\sin 90)}{"45.08"}$ or $\cos x = \frac{"40.4"^2+"45.08"^2-20^2}{2\times"40.4"\times"45.08"}$			M1	Correct trig statement for finding the required angle
			26.3		A1	26.3 – 26.4
						Total 7 marks