A / A* questions

2016

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Feb/March
2016

13 **(a)** Write 2016 as the product of prime factors.

.... [3]

(b) Write 2016 in standard form.

.... [1]

14 Simplify.

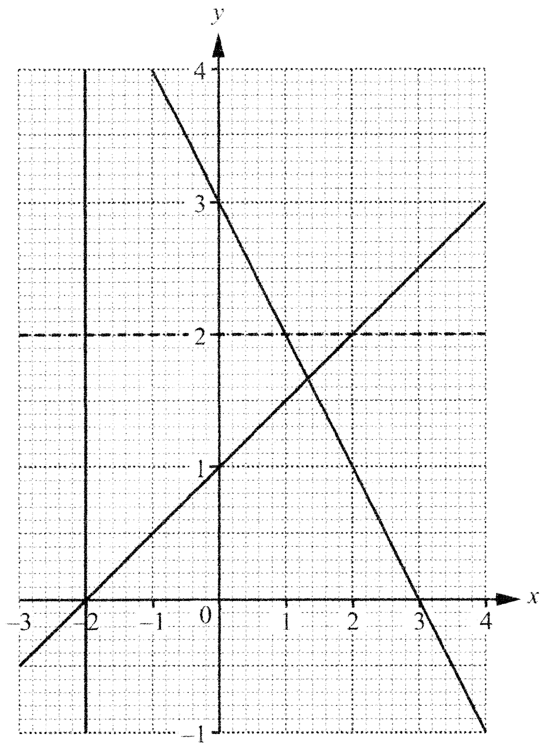
(a) $x^3y^4 \times x^5y^3$

.... [2]

(b) $(3p^2m^5)^3$

.... [2]

19



Find the four inequalities that define the region that is **not** shaded.

....

....

....

.... [5]

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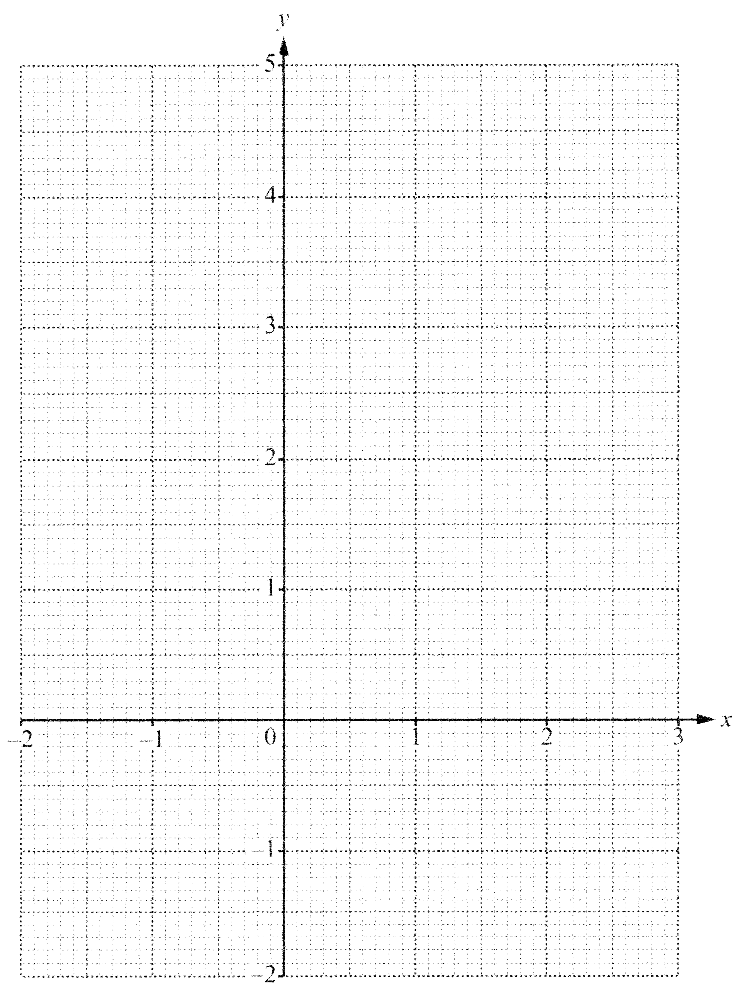
7 The table shows some values of $y = x + \frac{1}{x^2}$, $x \neq 0$.

x	-2	-1.5	-1	-0.75	-0.5		0.5	0.75	1	1.5	2	3
y	-1.75	-1.06	0	1.03			4.50	2.53	2		2.25	

(a) Complete the table of values. [3]

(b) On the grid, draw the graph of $y = x + \frac{1}{x^2}$ for $-2 \leqslant x \leqslant -0.5$ and $0.5 \leqslant x \leqslant 3$.



[5]

(c) Use your graph to solve the equation $x + \frac{1}{x^2} = 1.5$.

$x =$ .... [1]

(d) The line $y = ax + b$ can be drawn on the grid to solve the equation $\frac{1}{x^2} = 2.5 - 2x$.

(i) Find the value of a and the value of b.

$a =$ ....

$b =$ .... [2]

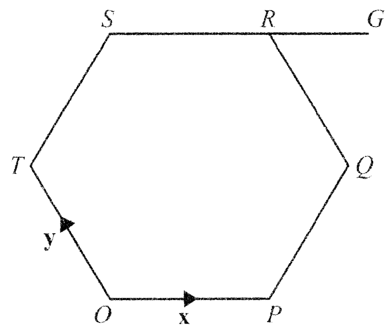
(ii) Draw the line $y = ax + b$ to solve the equation $\frac{1}{x^2} = 2.5 - 2x$.

$x =$ .... [3]

(e) By drawing a suitable tangent, find an estimate of the gradient of the curve at the point where $x = 2$.

.... [3]

9



NOT TO SCALE

O is the origin and *OPQRST* is a regular hexagon.

$\overrightarrow{OP} = \mathbf{x}$ and $\overrightarrow{OT} = \mathbf{y}$.

(a) Write down, in terms of **x** and/or **y**, in its simplest form,

(i) $\overrightarrow{QR}$,

$\overrightarrow{QR}$ = ... [1]

(ii) $\overrightarrow{PQ}$,

$\overrightarrow{PQ}$ = ... [1]

(iii) the position vector of *S*.

.... [2]

(b) The line *SR* is extended to *G* so that *SR* : *RG* = 2 : 1.

Find $\overrightarrow{GQ}$, in terms of **x** and **y**, in its simplest form.

$\overrightarrow{GQ}$ = ... [2]

(c) *M* is the midpoint of *OP*.

(i) Find $\overrightarrow{MG}$, in terms of **x** and **y**, in its simplest form.

$\overrightarrow{MG}$ = ... [2]

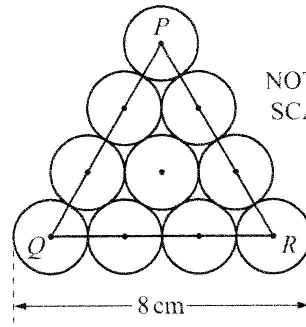
(ii) *H* is a point on *TQ* such that *TH* : *HQ* = 3 : 1.

Use vectors to show that *H* lies on *MG*.

[2]

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

Calculate the height of triangle PQR.

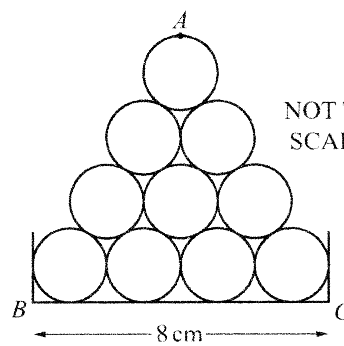


.... cm [3]

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

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

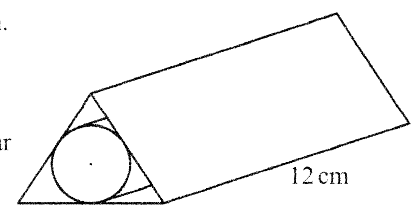
Find the height of A above the base, BC, of the tray.



.... cm [1]

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

Calculate the volume of this box.



.... cm^3 [5]

Question 11 is printed on the next page.

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16 **Without using a calculator**, work out $\frac{6}{7} \div 1\frac{2}{3}$.

Show all your working and give your answer as a fraction in its lowest terms.

.... [3]

17 Five angles of a hexagon are each 115°.

Calculate the size of the sixth angle.

.... [3]

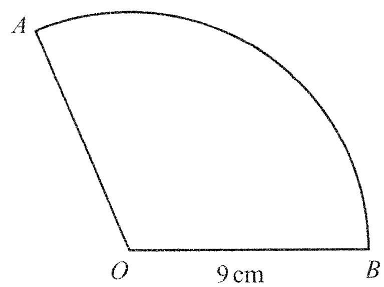
18 A car of length 4.3 m is travelling at 105 km/h.
It passes over a bridge of length 36 m.

Calculate the time, in seconds, it takes to pass over the bridge **completely**.

.... s [3]

20 AB is an arc of a circle, centre O, radius 9 cm.
The length of the arc AB is 6π cm.
The area of the sector AOB is $k\pi\ \text{cm}^2$.

Find the value of k.



NOT TO SCALE

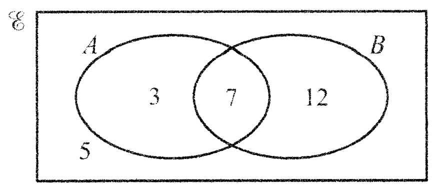
k = ... [3]

21 y is directly proportional to the positive square root of x.
When $x = 9$, $y = 12$.

Find y when $x = \frac{1}{4}$.

y = ... [3]

22



The Venn diagram shows the numbers of elements in each region.

(a) Find n($A \cap B'$).

.... [1]

(b) An element is chosen at random.

Find the probability that this element is in set B.

.... [1]

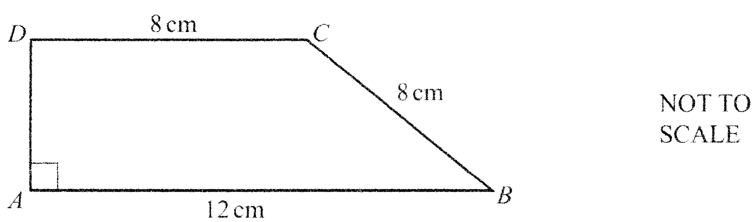
(c) An element is chosen at random from set A.

Find the probability that this element is also a member of set B.

.... [1]

(d) On the Venn diagram, shade the region $(A \cup B)'$. [1]

23



Calculate the area of this trapezium.

.... cm^2 [4]

24 Factorise completely.

(a) $2a + 4 + ap + 2p$

.... [2]

(b) $162 - 8t^2$

.... [2]

25 A is the point (4, 1) and B is the point (10, 15).

Find the equation of the perpendicular bisector of the line AB.

.... [6]

Question 26 is printed on the next page.

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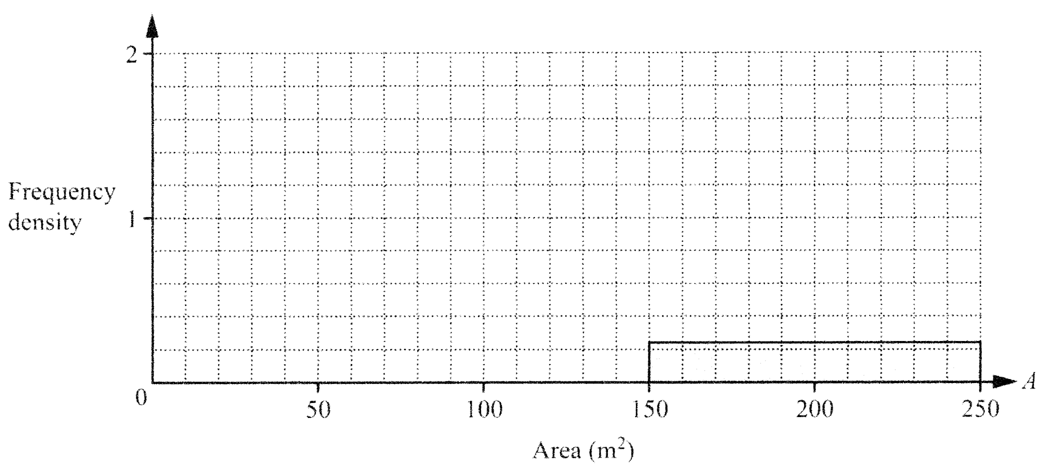
(b) The 200 students also estimate the total area, $A\,\text{m}^2$, of the windows in the classroom.
The results are shown in the table.

Area ($A\,\text{m}^2$)	$20 < A \leqslant 60$	$60 < A \leqslant 100$	$100 < A \leqslant 150$	$150 < A \leqslant 250$
Frequency	32	64	80	24

(i) Calculate an estimate of the mean.
Show all your working.

.... m^2 [4]

(ii) Complete the histogram to show the information in the table.



[4]

(iii) Two of the 200 students are chosen at random.

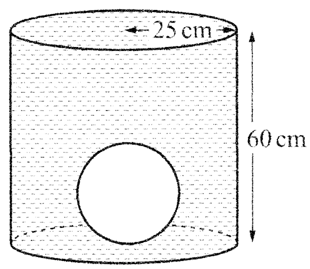
Find the probability that they both estimate that the area is greater than $100\,\text{m}^2$.

.... [2]

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

[2]

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

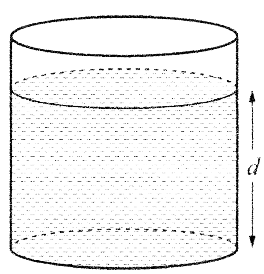


NOT TO SCALE

Calculate the volume of water required to fill the tank.

.... cm^3 [3]

(ii) The sphere is removed from the tank.



NOT TO SCALE

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

d = ... cm [2]

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

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

.... cm [3]

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

.... cm^2 [4]

(b) A car completes a 200 km journey with an average speed of x km/h.
The car completes the return journey of 200 km with an average speed of $(x + 10)$ km/h.

(i) Show that the difference between the time taken for each of the two journeys is $\frac{2000}{x(x+10)}$ hours.

[3]

(ii) Find the difference between the time taken for each of the two journeys when $x = 80$.
Give your answer in **minutes** and **seconds**.

.... min .... s [3]

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7 A map is drawn to a scale of 1 : 1 000 000.
A forest on the map has an area of $4.6\,cm^2$.

Calculate the actual area of the forest in square kilometres.

.... km^2 [2]

8 Solve the inequality $\frac{x}{3} + 5 > 2$.

.... [2]

9 A regular polygon has an interior angle of 172°.

Find the number of sides of this polygon.

.... [3]

10 Make p the subject of the formula.

$$rp + 5 = 3p + 8r$$

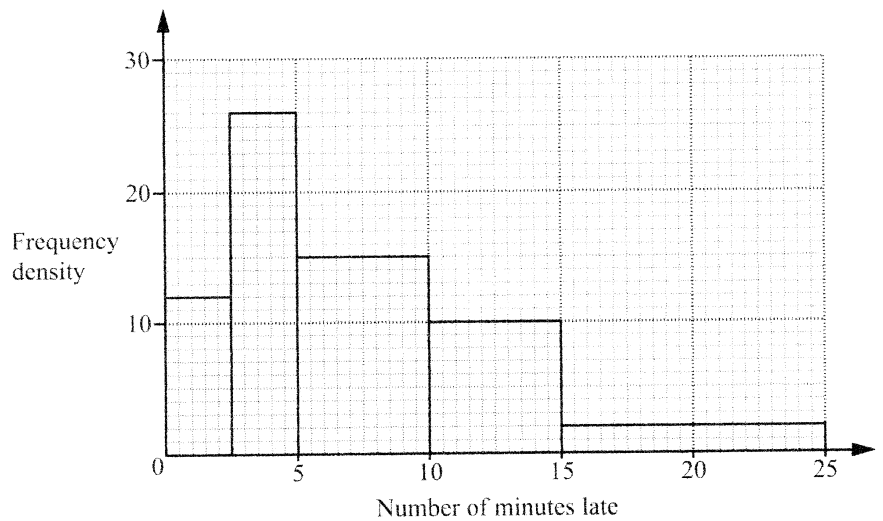
$p =$ .... [3]

11 Shahruk plays four games of golf.
His four scores have a mean of 75, a mode of 78 and a median of 77.

Work out his four scores.

.... [3]

20 Deborah records the number of minutes late, t, for trains arriving at a station.
The histogram shows this information.



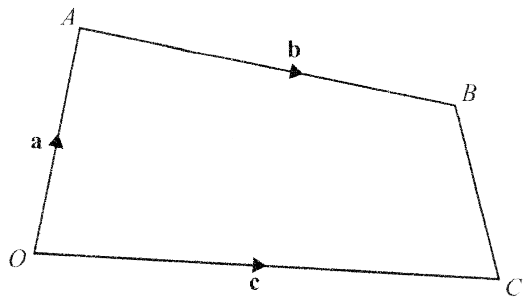
(a) Find the number of trains that Deborah recorded.

.... [2]

(b) Calculate the percentage of the trains recorded that arrived more than 10 minutes late.

....% [2]

24



In the diagram, O is the origin, $\overrightarrow{OA} = \mathbf{a}$, $\overrightarrow{OC} = \mathbf{c}$ and $\overrightarrow{AB} = \mathbf{b}$.
P is on the line AB so that $AP : PB = 2 : 1$.
Q is the midpoint of BC.

Find, in terms of **a**, **b** and **c**, in its simplest form

(a) $\overrightarrow{CB}$,

$\overrightarrow{CB}$ = ... [1]

(b) the position vector of Q,

.... [2]

(c) $\overrightarrow{PQ}$.

$\overrightarrow{PQ}$ = ... [2]

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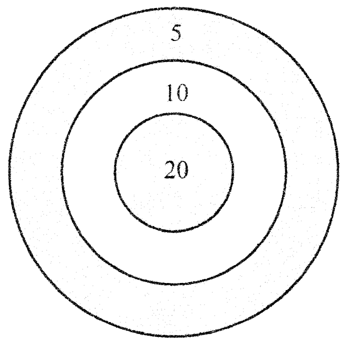
5 Kiah plays a game.
The game involves throwing a coin onto a circular board.
Points are scored for where the coin lands on the board.



If the coin lands on part of a line or misses the board then 0 points are scored.
The table shows the probabilities of Kiah scoring points on the board with one throw.

Points scored	20	10	5	0
Probability	x	0.2	0.3	0.45

(a) Find the value of x.

x = ... [2]

(b) Kiah throws a coin fifty times.

Work out the expected number of times she scores 5 points.

.... [1]

(c) Kiah throws a coin two times.

Calculate the probability that

(i) she scores either 5 or 0 with her first throw,

.... [2]

(ii) she scores 0 with her first throw and 5 with her second throw,

.... [2]

(iii) she scores a total of 15 points with her two throws.

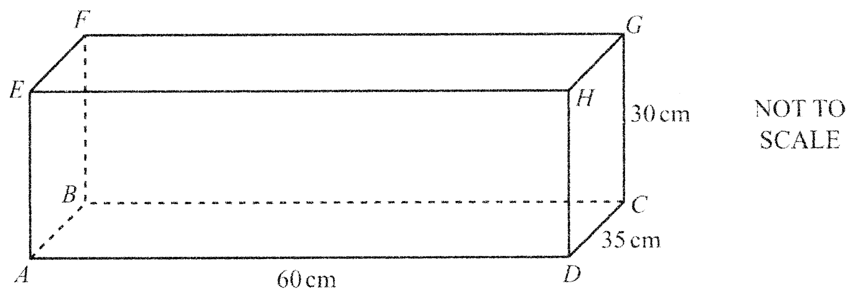
.... [3]

(d) Kiah throws a coin three times.

Calculate the probability that she scores a total of 10 points with her three throws.

.... [5]

6 The diagram shows a cuboid.



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

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

.... [1]

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

.... cm^2 [3]

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

.... m^2 [1]

(c) Calculate

(i) the length AG,

AG = ... cm [4]

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

.... [3]

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

[1]

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

Calculate the radius of the cylinder.

.... cm [3]

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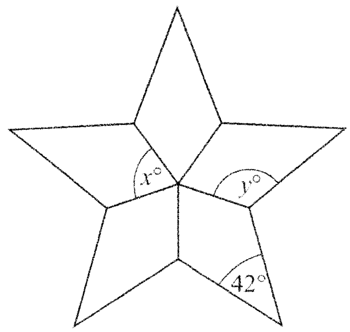


NOT TO SCALE

The diagram is made from 5 congruent kites.

Work out the value of

(a) x,

$x =$ .... [1]

(b) y.

$y =$ .... [2]

14 **(a)** $\mathscr{E} = \{x: 2 \leqslant x \leqslant 16, x \text{ is an integer}\}$
$M = \{\text{even numbers}\}$
$P = \{\text{prime numbers}\}$

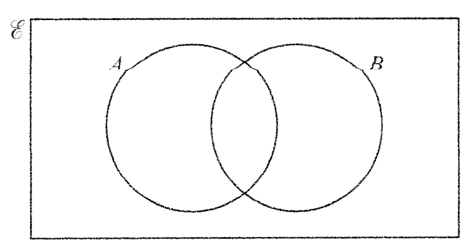
(i) Find n(M).

.... [1]

(ii) Write down the set $(P \cup M)'$.

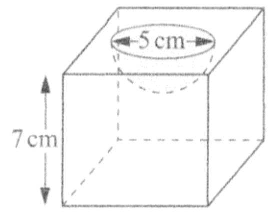
$(P \cup M)' = \{$..$\}$ [1]

(b) On the Venn diagram, shade $A \cap B'$.



[1]

15 A solid consists of a metal cube with a hemisphere cut out of it.



NOT TO SCALE

The length of a side of the cube is 7 cm.
The diameter of the hemisphere is 5 cm.

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

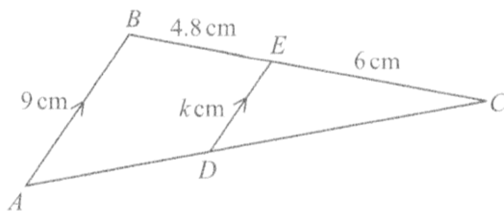
....cm^3 [3]

16 y is directly proportional to $(x + 2)^2$.
When $x = 8$, $y = 250$.

Find y when $x = 4$.

y = ... [3]

21 **(a)**



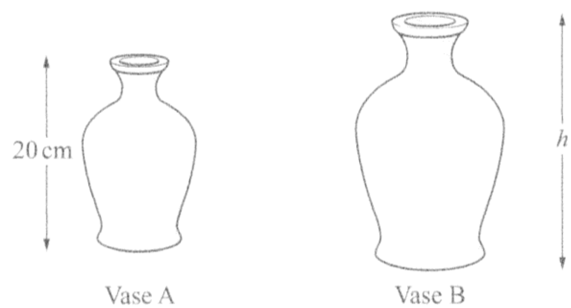
NOT TO SCALE

Triangles *CBA* and *CED* are similar.
AB is parallel to *DE*.
$AB = 9$ cm, $BE = 4.8$ cm, $EC = 6$ cm and $ED = k$ cm.

Work out the value of k.

k = ... [2]

(b)



NOT TO SCALE

The diagram shows two mathematically similar vases.
Vase A has height 20 cm and volume 1500 cm^3.
Vase B has volume 2592 cm^3.

Calculate h, the height of vase B.

h = ... cm [3]

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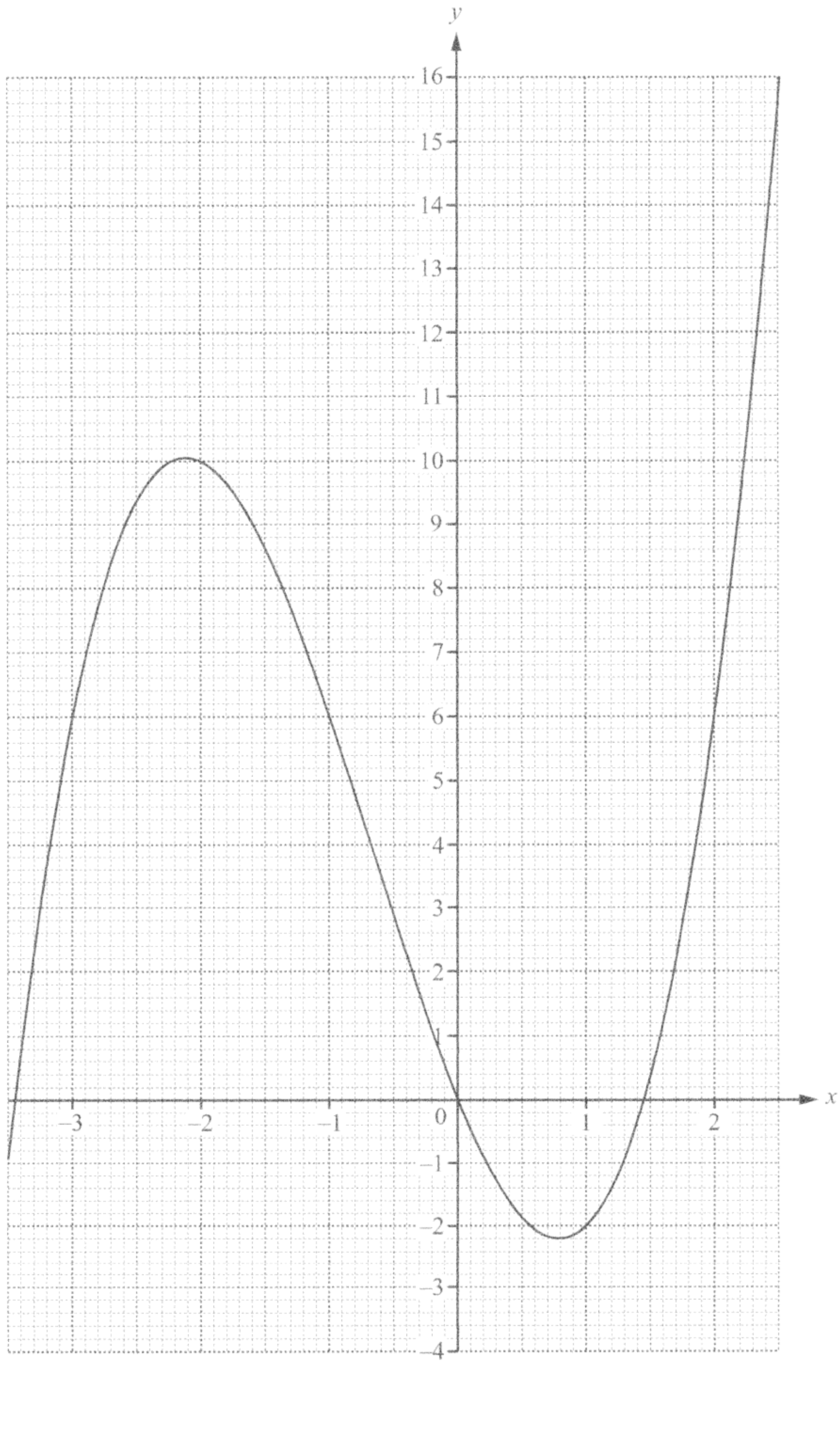
3 The diagram shows the graph of $y = f(x)$ for $-3.5 \leqslant x \leqslant 2.5$.



(a) **(i)** Find f(– 2).

.... [1]

(ii) Solve the equation $f(x) = 2$.

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

(iii) Two tangents, each with gradient 0, can be drawn to the graph of $y = f(x)$.

Write down the equation of each tangent.

....

.... [2]

(b) **(i)** Complete the table for $g(x) = \frac{2}{x} + 3$ for $-3.5 \leqslant x \leqslant -0.5$ and $0.5 \leqslant x \leqslant 2.5$.

x	–3.5	–3	–2	–1	–0.5		0.5	1	2	2.5
g(x)	2.4	2.3		1			7	5		3.8

[3]

(ii) On the grid opposite, draw the graph of $y = g(x)$. [4]

(iii) Use your graph to solve the equation $f(x) = g(x)$.

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

(c) Find gf(–2).

.... [2]

(d) Find $g^{-1}(5)$.

.... [1]

10

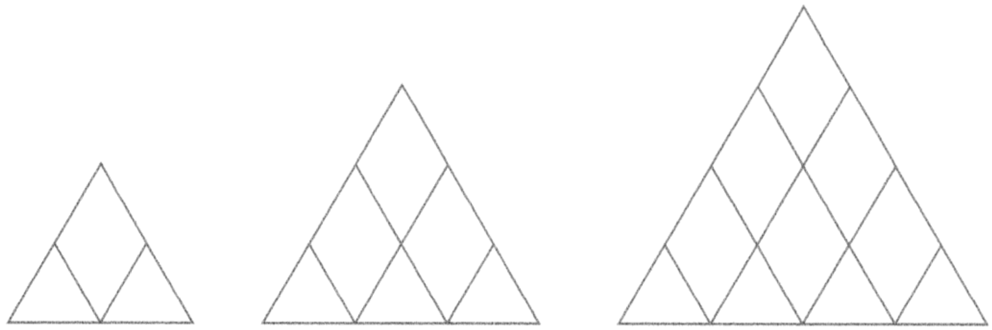


Diagram 1 Diagram 2 Diagram 3

Each diagram is made from tiles in the shape of equilateral triangles and rhombuses.
The length of a side of each tile is 1 unit.

(a) Complete the table below for this sequence of diagrams.

Diagram	1	2	3	4	5
Number of equilateral triangle shaped tiles	2	3	4	5	6
Number of rhombus shaped tiles	1	3	6		
Total number of tiles	3	6	10		
Number of 1 unit lengths	8	15	24		

[6]

(b) **(i)** The number of 1 unit lengths in Diagram n is $n^2 + 4n + p$.

Find the value of p.

p = ... [2]

(ii) Calculate the number of 1 unit lengths in Diagram 10.

.... [1]

(c) The total number of tiles in Diagram n is $an^2 + bn + 1$.

Find the value of a and the value of b.

a = ...

b = ... [5]

(d) Part of the Louvre museum in Paris is in the shape of a square-based pyramid made from glass tiles. Each of the triangular faces of the pyramid is represented by Diagram 17 in the sequence.

(i) Calculate the total number of glass tiles on one triangular face of this pyramid.

.... [2]

(ii) 11 tiles are removed from one of the triangular faces to create an entrance into the pyramid.

Calculate the total number of glass tiles used to construct this pyramid.

.... [1]

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20 A train travels for m minutes at a speed of x metres per second.

(a) Find the distance travelled, in **kilometres**, in terms of m and x.
Give your answer in its simplest form.

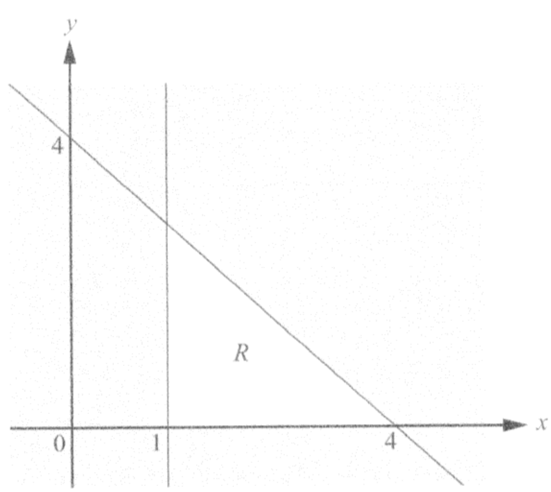
.... km [2]

(b) When $m = 5$, the train travels 10.5 km.

Find the value of x.

x = ... [2]

21



NOT TO SCALE

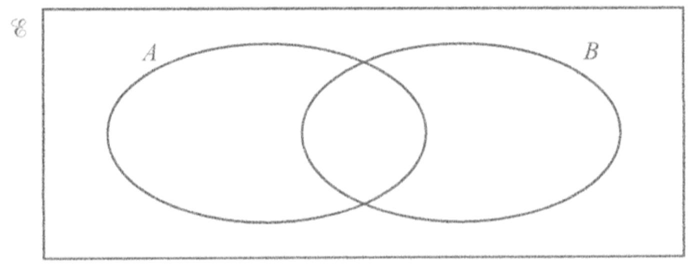
Write down the three inequalities that define the unshaded region, R.

....

....

.... [4]

22 **(a)** $n(\mathscr{E}) = 10$, $n(A) = 7$, $n(B) = 6$, $n(A \cup B)' = 1$.



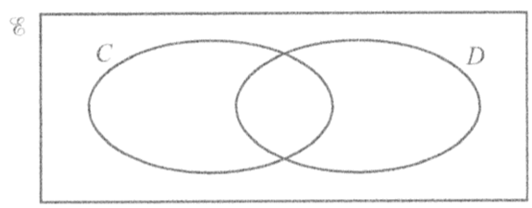
(i) Complete the Venn diagram by writing the number of elements in each subset. [2]

(ii) An element of ℰ is chosen at random.

Find the probability that this element is an element of $A' \cap B$.

.... [1]

(b) On the Venn diagram below, shade the region $C' \cap D'$.



[1]

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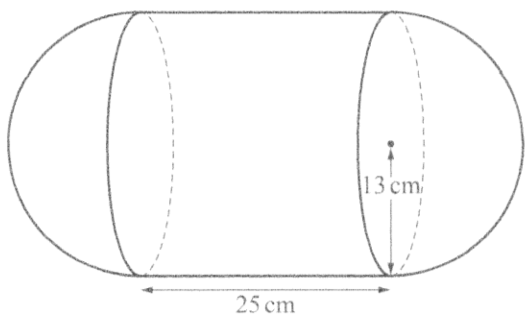
3 (a)



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

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

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

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

.... kg [4]

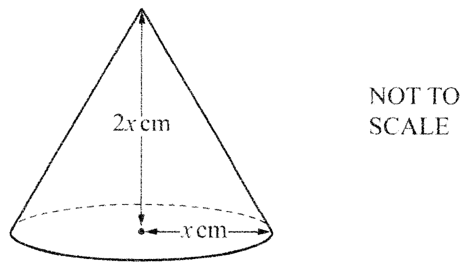
(ii) The surface of the solid is painted at a cost of $4.70 per square metre.

Calculate the cost of painting the solid.

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

$.. [4]

(b)



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

Find the value of x.

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

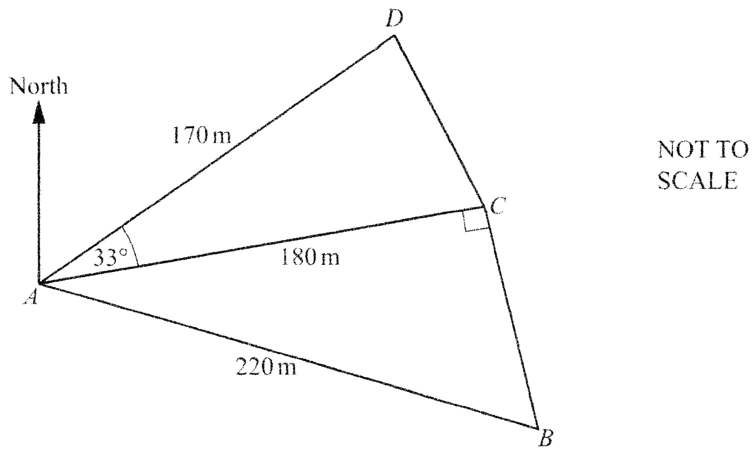
x = ... [3]

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

Calculate the surface area of the larger solid.

.... cm^2 [3]

6



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

(a) Calculate BC.

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

(b) Calculate CD.

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

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

.... m [2]

(d) The bearing of D from A is 047°.

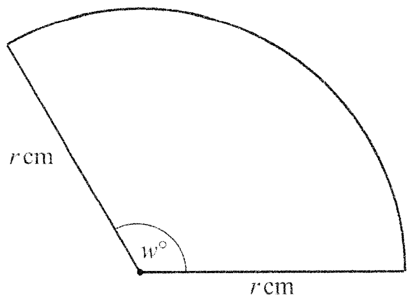
Calculate the bearing of B from A.

.... [3]

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

.... m^2 [3]

10 **(a)**

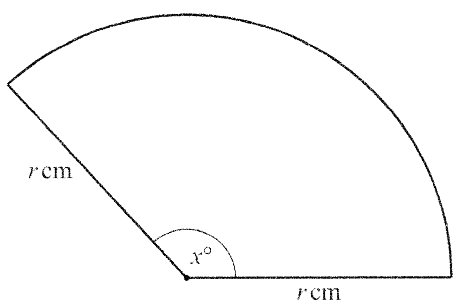


The area of this sector is r^2 square centimetres.

Find the value of w.

w = ... [3]

(b)

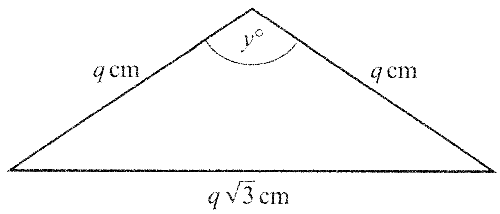


The perimeter of this sector is $2r + \frac{7\pi r}{10}$ centimetres.

Find the value of x.

x = ... [3]

(c)



NOT TO SCALE

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

Find the value of y.

$y =$ .... [4]

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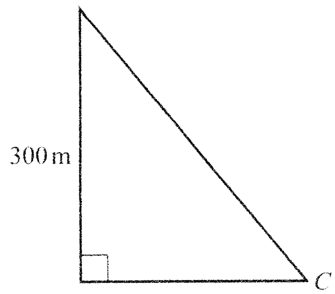
9 From the top of a building, 300 metres high, the angle of depression of a car, C, is 52°.



NOT TO SCALE

Calculate the horizontal distance from the car to the base of the building.

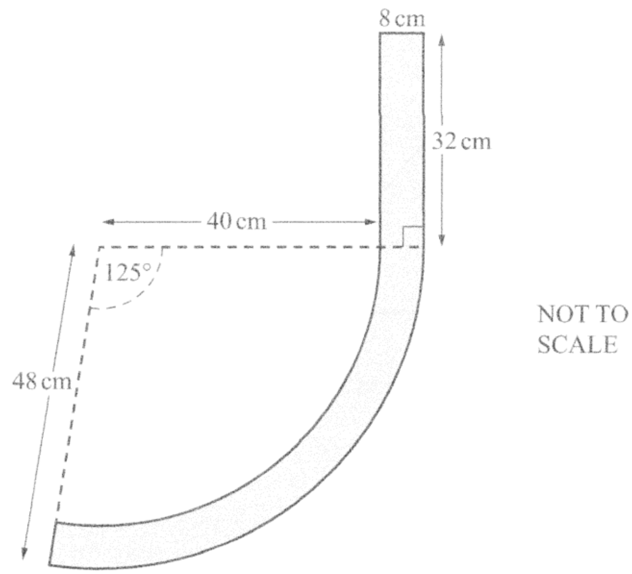
.... m [3]

10 The length of a backpack of capacity 30 litres is 53 cm.

Calculate the length of a mathematically similar backpack of capacity 20 litres.

.... cm [3]

17



The diagram shows the cross section of part of a park bench.
It is made from a rectangle of length 32 cm and width 8 cm and a curved section.
The curved section is made from two concentric arcs with sector angle 125°.
The inner arc has radius 40 cm and the outer arc has radius 48 cm.

Calculate the area of the cross section correct to the nearest square centimetre.

.... cm^2 [5]

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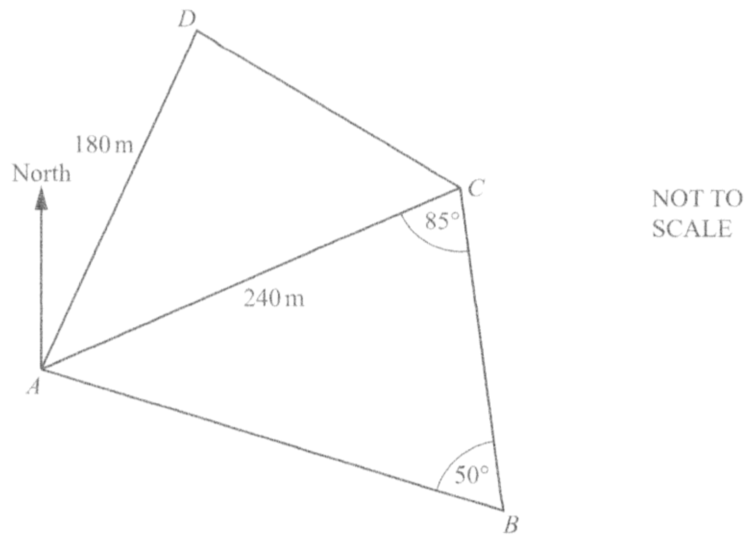
3



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

(a) Use the sine rule to calculate *AB*.

AB = ... m [3]

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

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

[3]

(c) Calculate *BD*.

BD = ... m [5]

(d) The bearing of *D* from *A* is 030°.

Find the bearing of

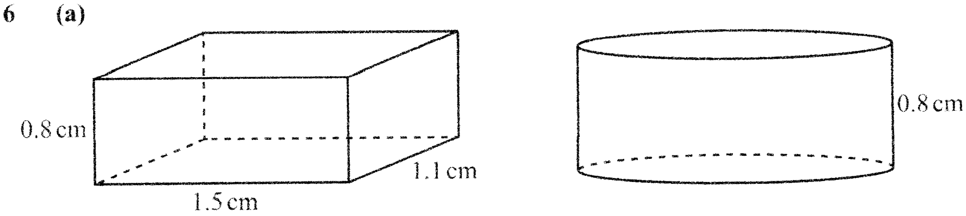
(i) *B* from *A*,

.... [1]

(ii) *A* from *B*.

.... [2]

6 **(a)**



NOT TO SCALE

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

(i) Calculate the volume of the cuboid.

.... cm^3 [2]

(ii) Calculate the radius of the cylinder.

.... cm [2]

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

.... cm^2 [5]

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

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

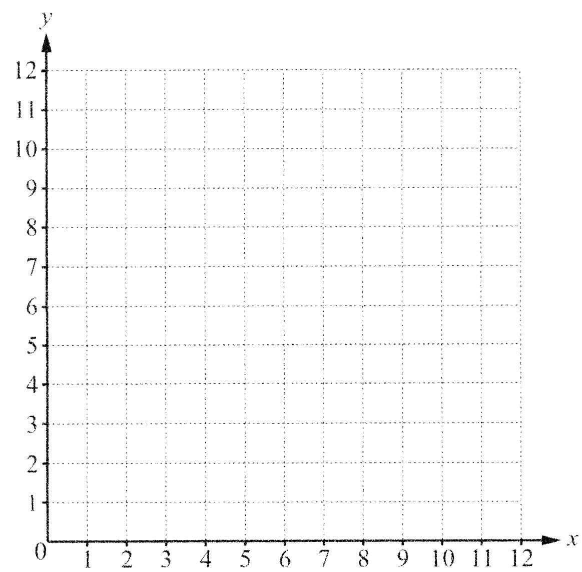
(i) One of the inequalities that shows this information is $2x + 3y < 24$.

Write down the other two inequalities.

....

.... [2]

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



[4]

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

Lowest cost = ... cents

x = ...

y = ... [3]

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1 $V = 4p^2$

Find V when $p = 3$.

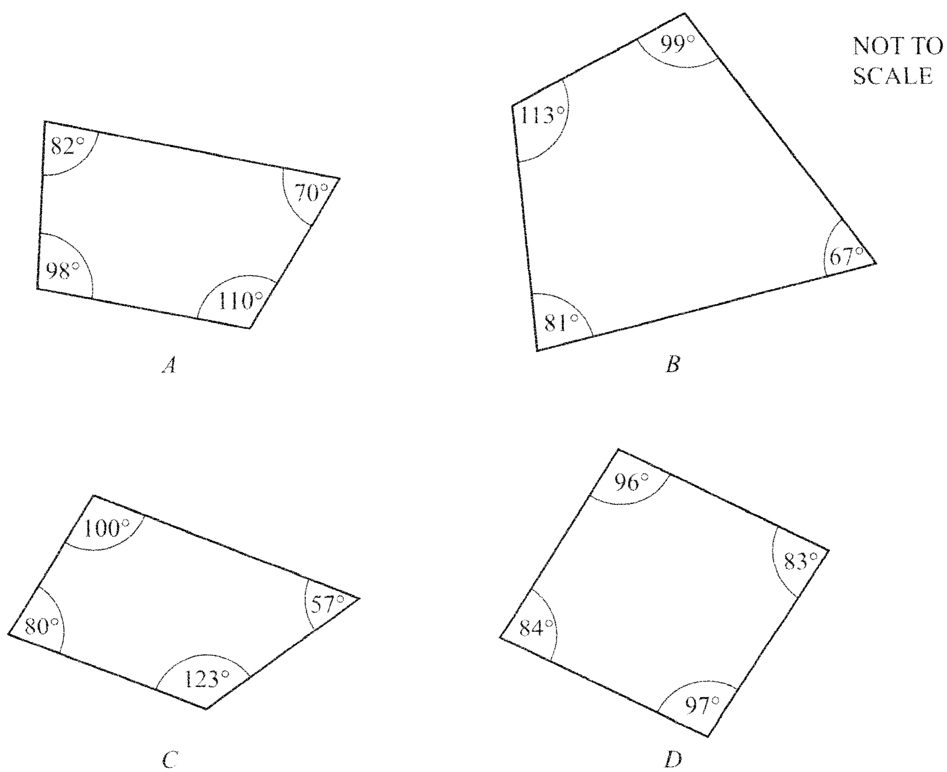
$V =$ .... [1]

2 Simplify.

$n^2 \times n^5$

.... [1]

3



The diagram shows four quadrilaterals A, B, C and D.

Which one of these could be a cyclic quadrilateral?

.... [1]

25 $\mathbf{A} = \begin{pmatrix} 4 & 2 \\ 2 & 1 \end{pmatrix}$ $\mathbf{B} = \begin{pmatrix} 7 & -3 \\ 4 & 5 \end{pmatrix}$ $\mathbf{C} = \begin{pmatrix} -2 & 3 & 1 \\ 4 & 5 & -1 \end{pmatrix}$ $\mathbf{D} = \begin{pmatrix} -9 \\ 0 \end{pmatrix}$

(a) Which of these four matrix calculations is **not** possible?

A + B **3C** **CB** **AD**

.... [1]

(b) Calculate **AB**.

$\begin{pmatrix} \quad & \quad \\ \quad & \quad \end{pmatrix}$ [2]

(c) Work out $\mathbf{B}^{-1}$, the inverse of **B**.

$\begin{pmatrix} \quad & \quad \\ \quad & \quad \end{pmatrix}$ [2]

(d) Explain why matrix **A** does not have an inverse.

.... [1]

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

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

Work out the length of the puzzle.

.... cm [3]

(d) **(i)** The area of another puzzle is $6610\,cm^2$.

Change $6610\,cm^2$ into m^2.

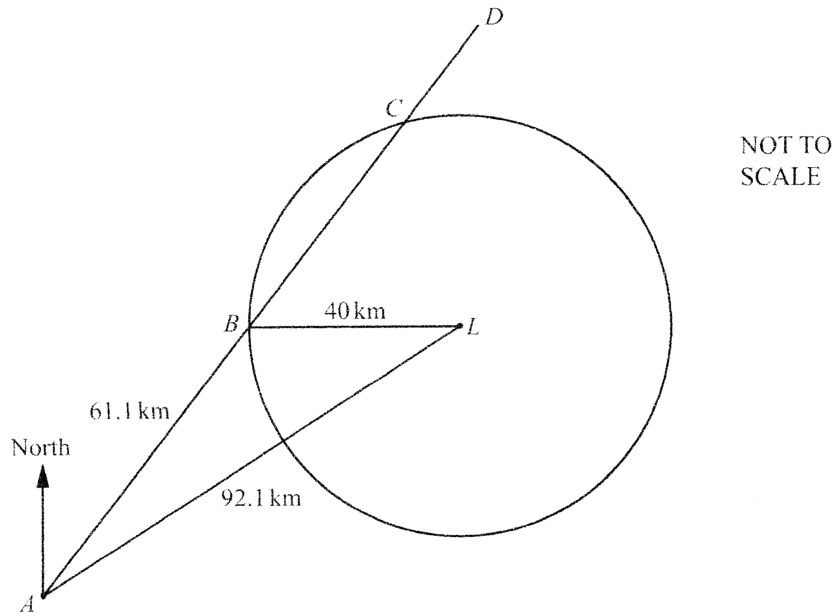
....m^2 [1]

(ii) The cost price of this puzzle is \$12.50 .
The selling price is \$18.50 .

Calculate the percentage profit.

.... % [3]

6



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

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

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

[4]

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

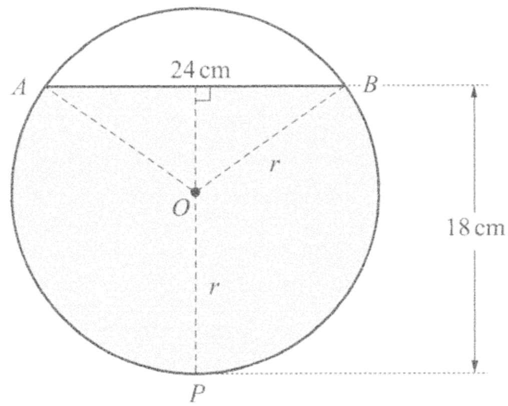
.... [4]

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

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

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

8



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

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

[4]

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

[2]

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

....cm^2 [3]

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

....cm^2 [3]

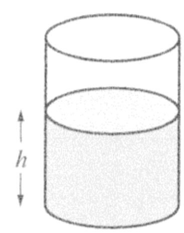
(iii) The length of the cylinder is 40 cm.

Calculate the volume of water in the cylinder.

....cm^3 [1]

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

Find h.



NOT TO SCALE

h = ... cm [2]

10 **(a)** Complete the table for the four sequences A, B, C and D.

	Sequence				Next term	*n*th term
A	2	5	8	11		
B	20	14	8	2		
C	1	4	9	16		
D	0	2	6	12		

[10]

(b) The sum of the first n terms of a sequence is $\frac{n(3n+1)}{2}$.

(i) When the sum of the first n terms is 155, show that $3n^2 + n - 310 = 0$.

[2]

(ii) Solve $3n^2 + n - 310 = 0$.

$n =$ .... or $n =$ .... [3]

(iii) Complete the statement.

The sum of the first .... terms of this sequence is 155. [1]