Cambridge
O Level

Cambridge International Examinations
Cambridge Ordinary Level

CANDIDATE NAME	
CENTRE NUMBER	
CANDIDATE NUMBER	

6783268523

MATHEMATICS (SYLLABUS D) **4024/22**

Paper 2 **May/June 2016**

2 hours 30 minutes

Candidates answer on the Question Paper.

Additional Materials: Geometrical instruments
Electronic calculator

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Section A
Answer **all** questions.

Section B
Answer any **four** questions.

If working is needed for any question it must be shown in the space below that question.
Omission of essential working will result in loss of marks.
You are expected to use an electronic calculator to evaluate explicit numerical expressions.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π.

The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 100.

DC (NF/SW) 115721/2
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Section A [52 marks]

Answer **all** questions in this section.

1 **(a)** Each year the Reds play the Blues in a baseball match.
In 2014, there were 40 500 tickets sold for the match.
In 2015, the number of tickets sold was 2.4% more than in 2014.

Calculate the number of tickets sold for the match in 2015.

Answer ..... [1]

(b) In 2015, the cost per ticket for the match was $68.25.
The cost per ticket for the match increased by 5% from 2014 to 2015.

Calculate the cost per ticket for the match in 2014.

Answer $ ..... [2]

(c) Calculate the percentage increase, from 2014 to 2015, in the total money taken for the match.

Answer ..... % [3]

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2 **(a)** $\overrightarrow{JK} = \begin{pmatrix} 2 \\ 5 \end{pmatrix}$ $\overrightarrow{KL} = \begin{pmatrix} 4 \\ -2 \end{pmatrix}$ $\overrightarrow{LM} = \begin{pmatrix} -1 \\ 3 \end{pmatrix}$

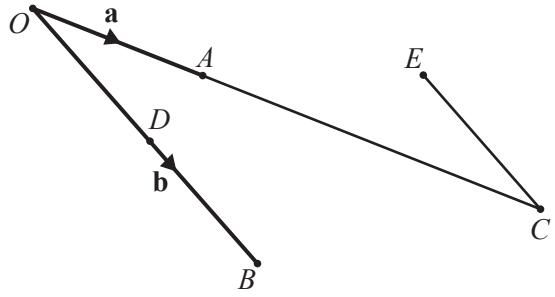
(i) Find $\overrightarrow{JM}$.

Answer [1]

(ii) Calculate $|\overrightarrow{KL}|$.

Answer ..... [2]

(b)



In the diagram, $\overrightarrow{OA} = \mathbf{a}$ and $\overrightarrow{OB} = \mathbf{b}$.
C is the point such that OAC is a straight line and $AC = 2OA$.
D is the midpoint of OB.
E is the point such that $\overrightarrow{EC} = \overrightarrow{OD}$.

(i) Express, as simply as possible, in terms of **a** and **b**,

(a) $\overrightarrow{AD}$,

Answer ..... [1]

(b) $\overrightarrow{EB}$.

Answer ..... [1]

(ii) Find $|\overrightarrow{EB}| : |\overrightarrow{AD}|$.

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

3 Steven asked 25 women how many children they have.
The results are summarised in the table below.

Number of children	Frequency
0	7
1	5
2	6
3	4
4	3

(a) Find

(i) the mean,

Answer ..... [2]

(ii) the median,

Answer ..... [1]

(iii) the mode.

Answer ..... [1]

(b) Steven says that the mode is the average that best represents the data.

Explain why Steven is wrong.

Answer ..... [1]

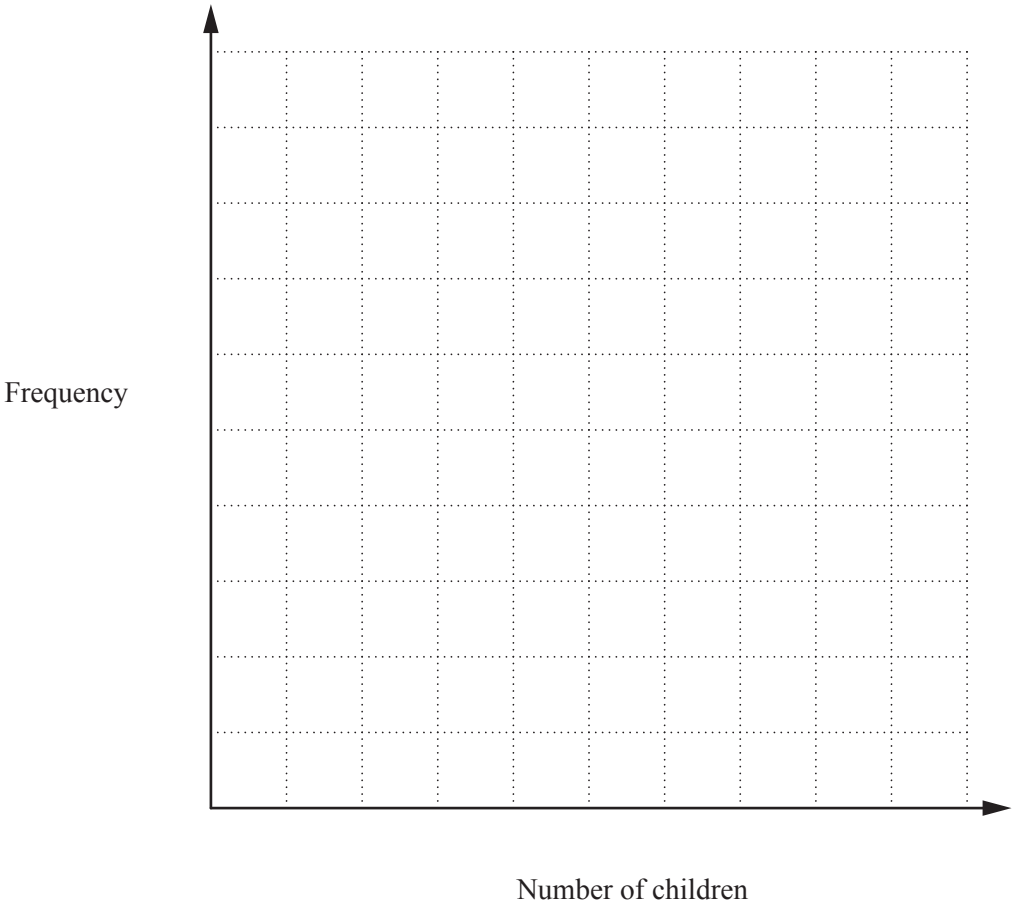
(c) Steven chooses two women at random from the group.

Calculate the probability that **both** of them have just one child.
Give your answer as a fraction in its simplest form.

Answer ..... [2]

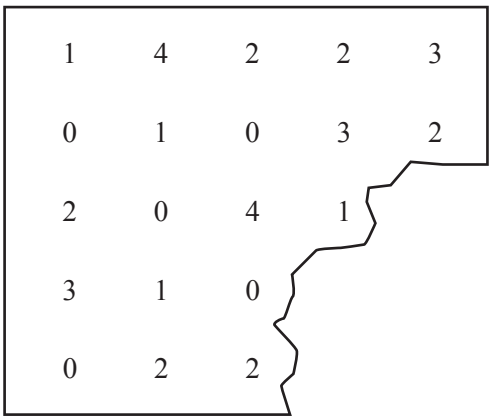
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(d) Draw a bar chart to represent this data.



[2]

(e) Steven shows Frank the paper on which he recorded the data from his survey.
Part of the paper has been torn.

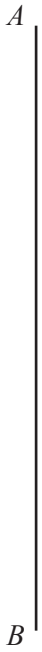


Which five numbers are missing from the paper?

Answer ..... , ... , ... , ... , ... [1]

4 **(a)** Triangle ABC has sides $AB = 8\,\text{cm}$, $AC = 7\,\text{cm}$ and $BC = 12\,\text{cm}$.

(i) Use a ruler and compasses to construct triangle ABC.
Side AB has been drawn for you.



[2]

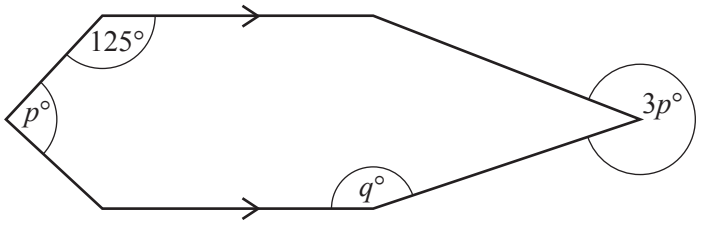
(ii) Measure $B\hat{A}C$.

Answer ..... [1]

(b) Calculate the interior angle of a regular 12-sided polygon.

Answer ..... [2]

(c)



The diagram shows a hexagon with two parallel sides and one horizontal line of symmetry.

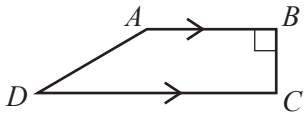
(i) Calculate p .

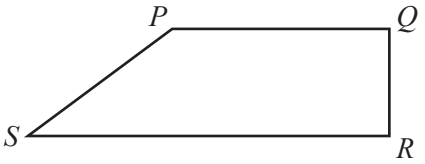
Answer ..... [1]

(ii) Calculate q .

Answer ..... [2]

(d)





Trapezium $PQRS$ is similar to trapezium $ABCD$.
AB is parallel to DC and $A\hat{B}C = 90°$.
$DC = 2AB$, $BC = \frac{1}{2}AB$ and $PQ = \frac{3}{4}DC$.

Given that $BC = x$ cm, find an expression, in terms of x, for the area of $PQRS$.

Answer ..... cm^2 [3]

5 **(a)** Factorise fully $8x^2y - 12x^5$.

Answer ..... [1]

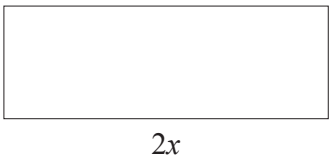
(b) Solve $4x - 2(x + 5) = 3$.

Answer ..... [2]

(c) Solve $7 - 5y < 20$.

Answer y ..... [2]

(d) A rectangle has length $2x$ cm, perimeter 18 cm and area 10 cm^2.



(i) Show that $2x^2 - 9x + 5 = 0$.

[2]

(ii) Solve $2x^2 - 9x + 5 = 0$, giving your answers correct to 2 decimal places.

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

(iii) Find the difference between the length and the width of the rectangle.

Answer ..... cm [1]

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6 **(a)** $\mathscr{E} = \{ 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12 \}$
$A = \{ x : x \text{ is a prime number} \}$
$B = \{ x : x \text{ is an even number} \}$
$C = \{ x : x \text{ is a multiple of 5} \}$

(i) List the members of the subsets

(a) $B \cap C$,

Answer ..... [1]

(b) $(A \cup B \cup C)'$,

Answer ..... [1]

(c) $A \cap B'$.

Answer ..... [1]

(ii) A number q is chosen at random from $\mathscr{E}$.

Find the probability that $q \in A \cap B'$.

Answer ..... [1]

(b) $\mathbf{X} = \begin{pmatrix} 3 & -1 \\ 2 & 0 \end{pmatrix}$ $\mathbf{Y} = \begin{pmatrix} 2 & 2 \\ -1 & 1 \end{pmatrix}$

Find

(i) $2\mathbf{X} + \mathbf{Y}$,

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

(ii) $\mathbf{Y}^{-1}$.

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

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Section B [48 marks]

Answer **four** questions in this section.
Each question in this section carries 12 marks.

7 One day, garage A records the amount of petrol bought by the first 120 customers.
The results are summarised in the table below.

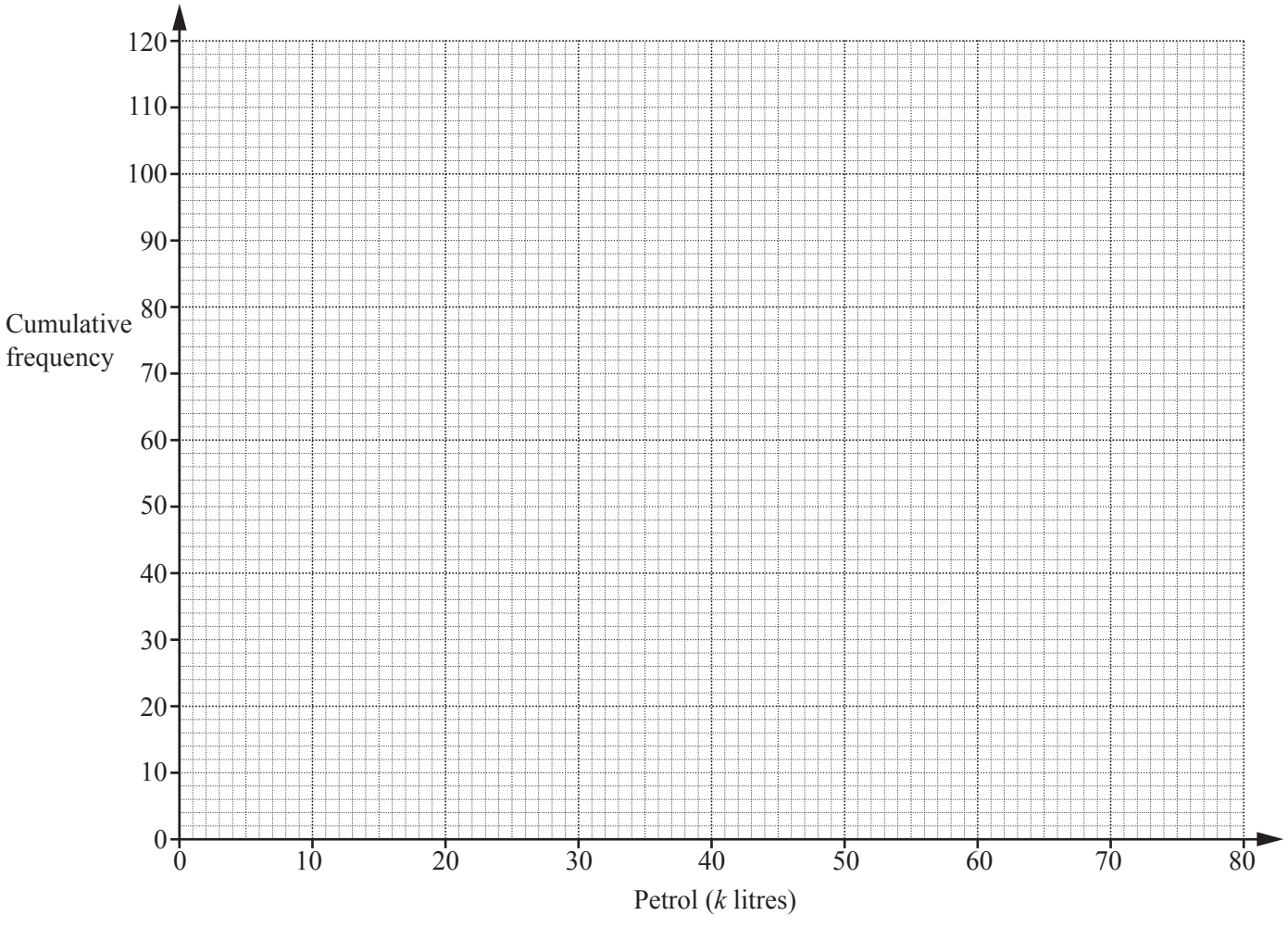
Petrol (k litres)	$0 < k \leqslant 10$	$10 < k \leqslant 20$	$20 < k \leqslant 30$	$30 < k \leqslant 40$	$40 < k \leqslant 50$	$50 < k \leqslant 60$	$60 < k \leqslant 70$	$70 < k \leqslant 80$
Number of customers	9	13	36	30	16	9	5	2

(a) Complete the cumulative frequency table below.

Petrol (k litres)	$k \leqslant 10$	$k \leqslant 20$	$k \leqslant 30$	$k \leqslant 40$	$k \leqslant 50$	$k \leqslant 60$	$k \leqslant 70$	$k \leqslant 80$
Cumulative frequency	9	22						120

[1]

(b) On the grid below, draw a cumulative frequency curve to represent this data.



[3]

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(c) Use your graph to estimate

(i) the median,

Answer ..... litres [1]

(ii) the 90th percentile of the distribution.

Answer ..... litres [1]

(d) On the same day, garage B also recorded the amount of petrol bought by its first 120 customers.

The results are summarised below.

6 customers bought 10 litres or less.
The most petrol bought by any customer was 60 litres.
The median amount of petrol bought was 34 litres.
The lower quartile of the distribution was 25 litres.
The interquartile range of the distribution was 19 litres.

Draw the cumulative frequency curve for garage B on the grid on the previous page. [3]

(e) Petrol is priced at \$2.60 per litre at both garages.
Garage A offers a gift to customers who buy over 35 litres.
Garage B offers a gift to customers who spend over \$104.

Use your graphs to estimate the number of these customers offered a gift at each garage and complete the sentence below.
Show your working.

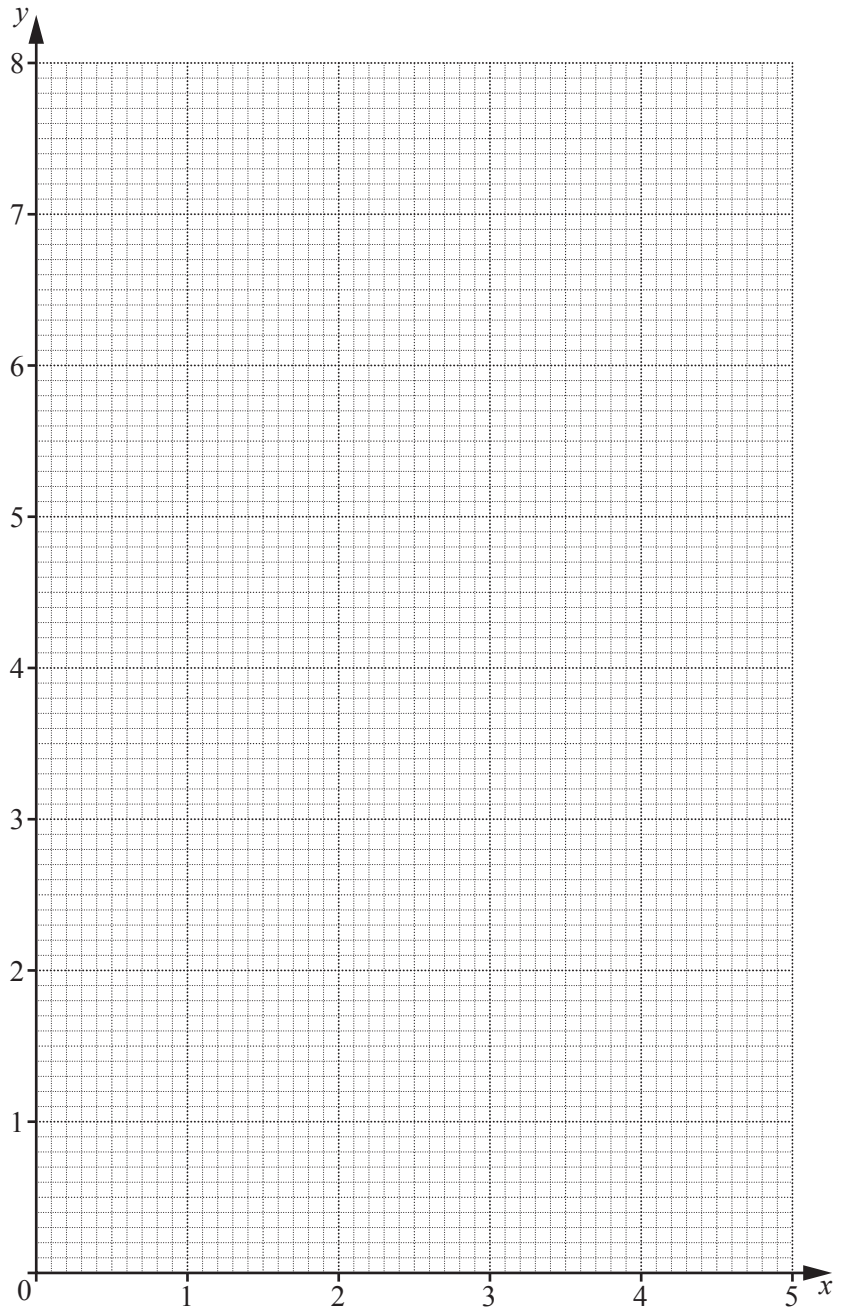
Answer Garage ..... offers a gift to ..... more customers than garage ..... [3]

8 The table below shows some values of x and the corresponding values of y for $y = \frac{1}{4} \times 2^x$.

x	0	1	2	3	4	5
y	$\frac{1}{4}$		1	2	4	8

(a) Complete the table. [1]

(b) On the grid below, draw the graph of $y = \frac{1}{4} \times 2^x$.



[2]

(c) By drawing a suitable line, find the gradient of your graph where $x = 4$.

Answer ..... [2]

(d) (i) Show that the line $2x + y = 6$, together with the graph of $y = \frac{1}{4} \times 2^x$, can be used to solve the equation

$$2^x + 8x - 24 = 0 .$$

[1]

(ii) Hence solve $2^x + 8x - 24 = 0$.

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

(e) The points P and Q are (2, 3) and (5, 4) respectively.

(i) Find the gradient of PQ.

Answer ..... [1]

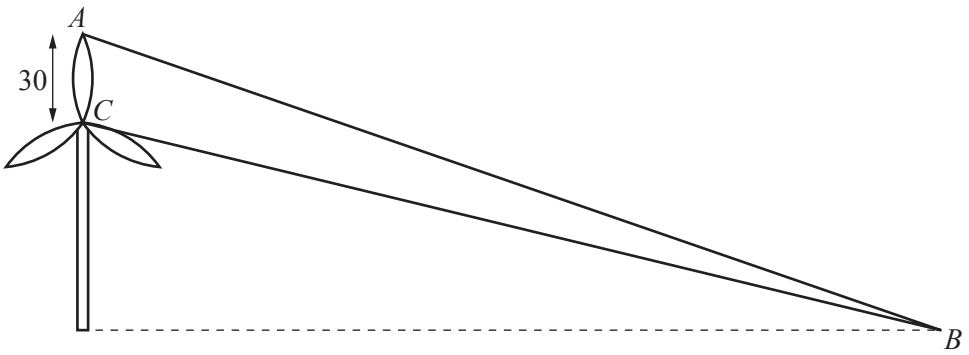
(ii) On the grid, draw the line l, parallel to PQ, that touches the curve $y = \frac{1}{4} \times 2^x$. [1]

(iii) Write down the equation of l.

Answer ..... [2]

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9 (a)



The diagram shows a vertical wind turbine with blades 30 m long.
The blades are stationary with the point A being the maximum distance possible from the horizontal ground.
The point B is such that the angle of elevation of A from B is 34° and the angle of elevation of the centre of the blades, C, from B is 25°.

Calculate the distance AB.

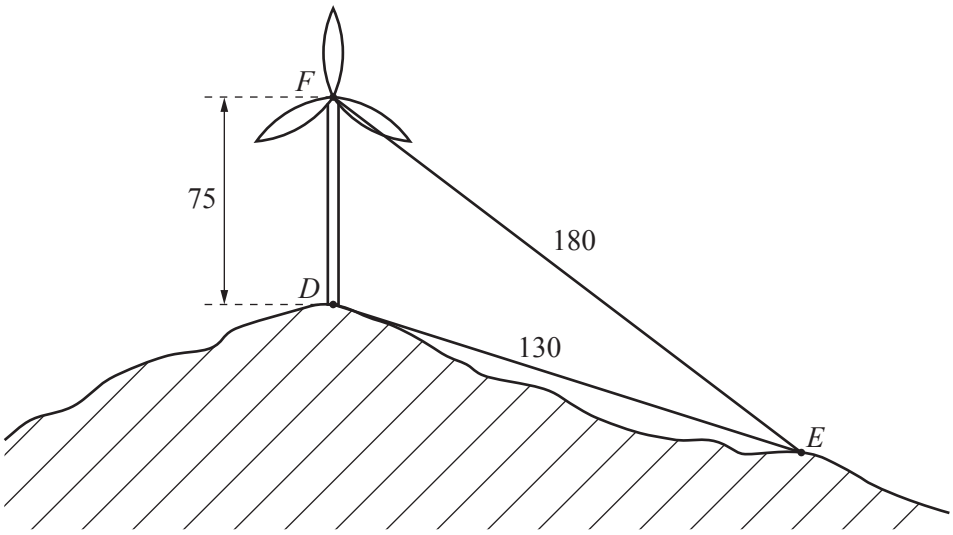
Answer ..... m [3]

(b) A different wind turbine, shown in the diagram on the next page, has the centre of its blades, F, 75 m from the base of the turbine, D.
Point E is on sloping ground, 180 m from F and 130 m from D.

Calculate the angle of depression of E from F.

Answer ..... [4]

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(c) *P* is the point on a blade which is furthest from the centre of the blades.
Each blade is 30 m long.

(i) Calculate the distance travelled by *P* as the blade completes one revolution.

Answer ..... m [1]

(ii) The blade completes 15 revolutions per minute.

Calculate the speed of *P*, giving your answer in kilometres per hour.

Answer ..... km/h [2]

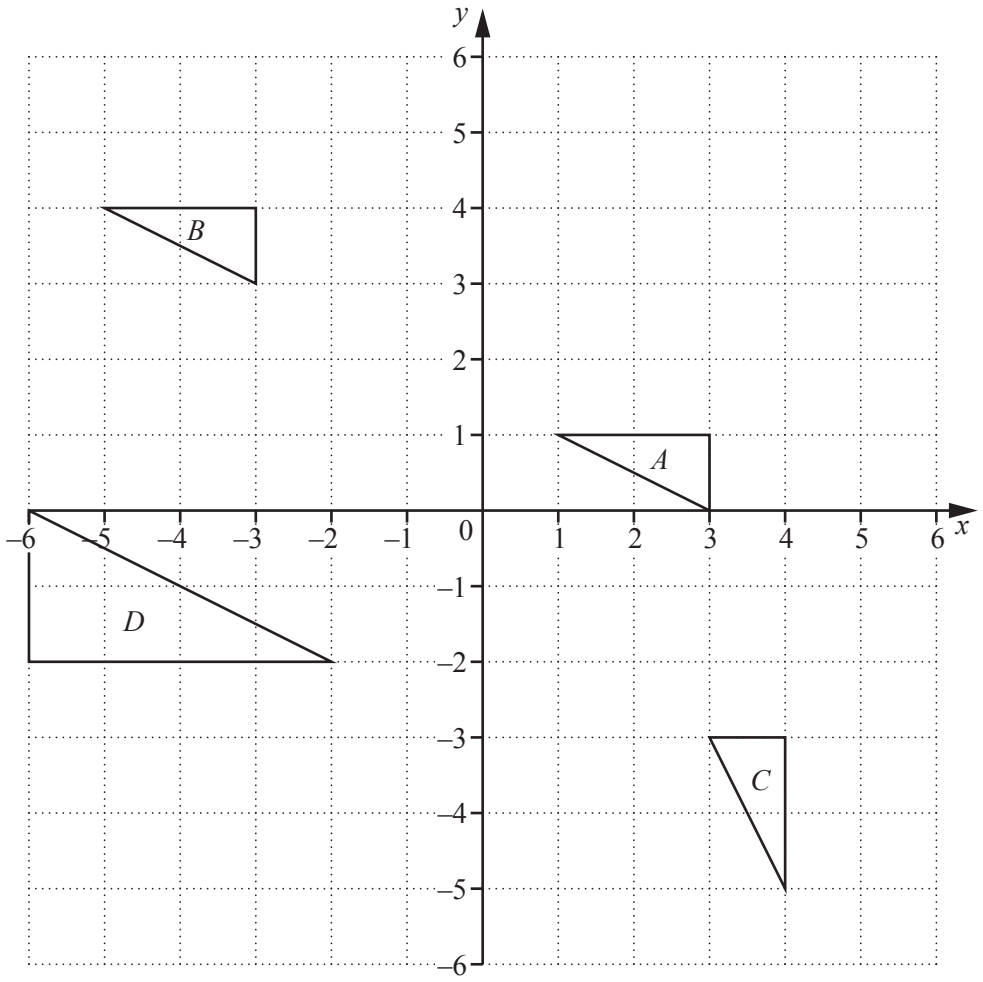
(iii) A point *Q* lies on the straight line between *P* and the centre of the blades.
Q travels 90 m as the blade completes one revolution.

Calculate *PQ*.

Answer ..... m [2]

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10 Triangles A, B, C and D are drawn on a centimetre square grid.



(a) The perimeter of triangle A is $(a + \sqrt{b})$ cm, where a and b are integers.

Find a and b.

Answer $a =$ ..... $b =$ ..... [2]

(b) Triangle A is mapped onto triangle B by the translation T.

Write down the column vector that represents T.

Answer $\begin{pmatrix} \quad \\ \quad \end{pmatrix}$ [1]

(c) Describe fully the **single** transformation that maps triangle B onto triangle C.

Answer .....

..... [2]

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(d) Describe fully the **single** transformation that maps triangle B onto triangle D.

Answer .....

..... [3]

(e) Write down the matrix that represents the transformation which maps triangle D onto triangle A.

Answer [1]

(f) The transformation V is a reflection in the line $y = 0$.
The transformation W is a rotation 90° clockwise about (0, 0).
The single transformation X is equivalent to the transformation V followed by the transformation W.

(i) The point (g, h) is mapped onto the point P by the transformation X.

Find the coordinates of P.

Answer (..... , ...) [1]

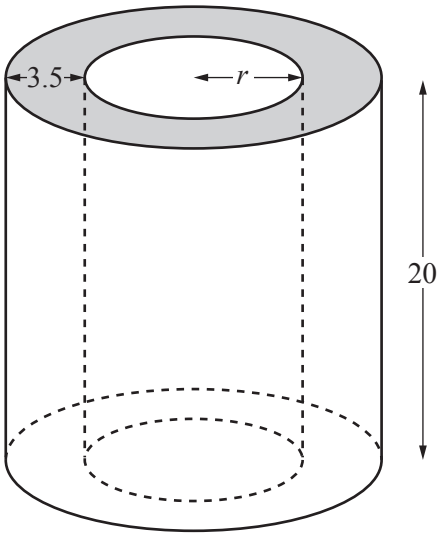
(ii) Describe fully the **single** transformation X.

Answer .....

..... [2]

11 **[Volume of a cone = $\frac{1}{3}\pi r^2 h$]**

(a)



Solid I

Solid I is a cylinder with a small cylinder removed from its centre, as shown in the diagram.
The height of each cylinder is 20 cm and the radius of the small cylinder is r cm.
The radius of the large cylinder is 3.5 cm greater than the radius of the small cylinder.
The volume of Solid I is 3000 cm^3.

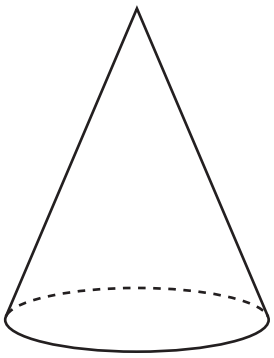
(i) Calculate r.

Answer $r =$ ..... [4]

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(ii) Solid II is a cone with volume of $3000\,cm^3$.
The perpendicular height of the cone is twice its radius.

Which solid is the taller and by how much?

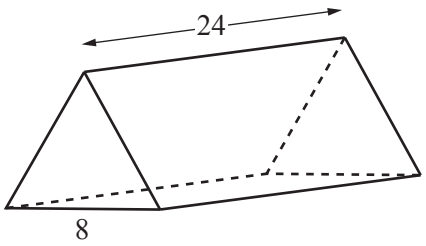


Solid II

Answer Solid ..... is the taller by ..... cm [4]

(b) The diagram shows a triangular prism of length 24 cm.
Its cross-section is an equilateral triangle with sides 8 cm.

Calculate the **total** surface area of the prism.



Answer ..... cm^2 [4]

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