Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

C300UB0-1

A23-C300UB0-1

FRIDAY, 10 NOVEMBER 2023 – MORNING

MATHEMATICS – Component 2
Calculator-Allowed Mathematics
HIGHER TIER

2 hours 15 minutes

ADDITIONAL MATERIALS

An additional formulae sheet.
A calculator will be required for this examination.
A ruler, protractor and a pair of compasses may be required.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Do not use gel pen or correction fluid.
You may use a pencil for graphs and diagrams only.
Write your name, centre number and candidate number in the spaces at the top of this page.
Answer **all** the questions in the spaces provided.
If you run out of space, use the additional page(s) at the back of the booklet, taking care to number the question(s) correctly.
Take π as 3·142 or use the π button on your calculator.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.
Unless stated, diagrams are not drawn to scale.
Scale drawing solutions will not be acceptable where you are asked to calculate.
The number of marks is given in brackets at the end of each question or part-question.
You are reminded of the need for good English and orderly, clear presentation in your answers.

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	3	
2.	4	
3.	5	
4.	5	
5.	8	
6.	4	
7.	6	
8.	7	
9.	6	
10.	2	
11.	4	
12.	2	
13.	10	
14.	5	
15.	4	
16.	6	
17.	4	
18.	5	
19.	7	
20.	9	
21.	5	
22.	6	
23.	3	
Total	120	

NOV23C300UB0101

Examiner only

1. Shortbread biscuits are made from flour, butter and sugar.
Their masses are in the ratio 4 : 3 : 2 respectively.

(a) What fraction of a shortbread biscuit is made up of sugar? [1]

$\frac{2}{9}$

(b) 1400 g of flour is used to make a batch of shortbread biscuits.
How many grams of butter is used for this batch of shortbread biscuits? [2]

F B S
4 3 2
×350 → 1050
×350
1400

1050 g of butter.

Examiner only

2. Lucy bought a car 9 years ago for £12250.

The car depreciated in value by 18% in the **first** year.
In each of the following years, her car depreciated by 15% of its previous year's value.

By how much has the car decreased in value in the last 9 years? [4]

$12250 \times 0.82 \times 0.85^{8}$

$= 2737.17$

$12250 - 2737.17$

Lucy's car has decreased in value by £9512.83

Examiner only

3. Regan caught 70 fish on a fishing trip.
He measured the length of each of the fish in centimetres.

The table shows his results.

Length, l (centimetres)	Number of fish	mid	
$60 \leqslant l < 65$	19	62.5	1187.5
$65 \leqslant l < 70$	17	67.5	1147.5
$70 \leqslant l < 75$	23	72.5	1667.5
$75 \leqslant l < 80$	10	77.5	775
$80 \leqslant l < 85$	1	82.5	82.5

(a) Calculate an estimate for the mean length of these fish. [4]

$\Sigma = 4860$

$\frac{4860}{70} = 69.43$

(b) Regan thinks that the median length of fish is in the group $70 \leqslant l < 75$.
Is Regan correct?

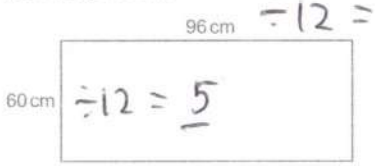
Yes ☐ No ☑

Give the reason for your answer. [1]

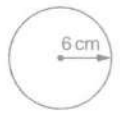
35th (.5) is in the group $65 \leqslant l < 70$

Examiner only

4. Jan has a large piece of card.
The card has width 60 cm and length 96 cm.



She uses a machine to cut identical circles out of the card.
Each circle has a radius of 6 cm.



d = 12

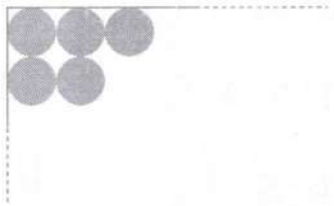


Diagram not drawn to scale

Jan has cut five circles as shown on the diagram above.
She continues in this way to cut as many circles as possible from the card.

(a) What is the maximum number of circles Jan can cut out of the card? [1]

8 × 5 = 40

Examiner only

(b) Jan cuts out the maximum number of circles from the card.
What area of card is left over? [4]

Whole = 96 × 60 = 5760 cm²

circles = 40 × π × 6² = 1440π cm²

Area of card left over 1236.1 cm²

[ms 1235.5 → 1238.4]

Examiner only

5. (a) Expand and simplify $(x+3)(x+7)$. [2]

$x^2+7x+3x+21 = x^2+10x+21$

(b) Solve $7x+6=4x+7$. [2]

$3x = 1 \qquad x = \frac{1}{3}$

(c) Factorise y^2-400. [1]

$(y+20)(y-20)$

(d) Solve the following simultaneous equations. [3]

$7x-3y=26$

$x+y=3$ (×3)

You must show all your working.

$7x-3y = 26$

$3x+3y = 9$ +

$10x = 35$

$x = \frac{35}{10} = 3{\cdot}5$

$3{\cdot}5+y = 3$

$y = -0{\cdot}5$

$x =$ 3·5 $y =$ −0·5

Examiner only

6. The two shapes below are similar.

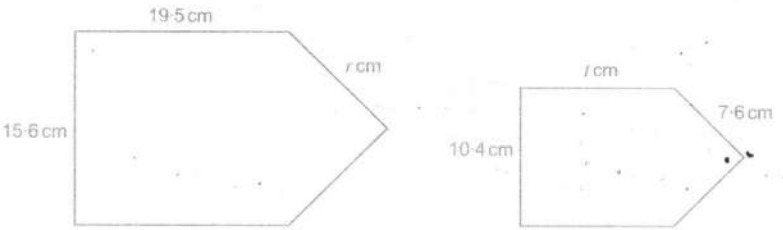


Diagram not drawn to scale

Find the value of r and the value of t. [4]

$sf = 10{\cdot}4 \div 15{\cdot}6 = \frac{2}{3}$

$t = 19{\cdot}5 \times \frac{2}{3} = 13$

$r = 7{\cdot}6 \div \frac{2}{3} = 11{\cdot}4$

$r =$ 11·4 $t =$ 13

Turn over.

Examiner only

7. Vaughan cycles down a track from the top of a mountain to the bottom.
The track goes down at an angle of 48° to the horizontal.
Vaughan is 800 feet above ground level.

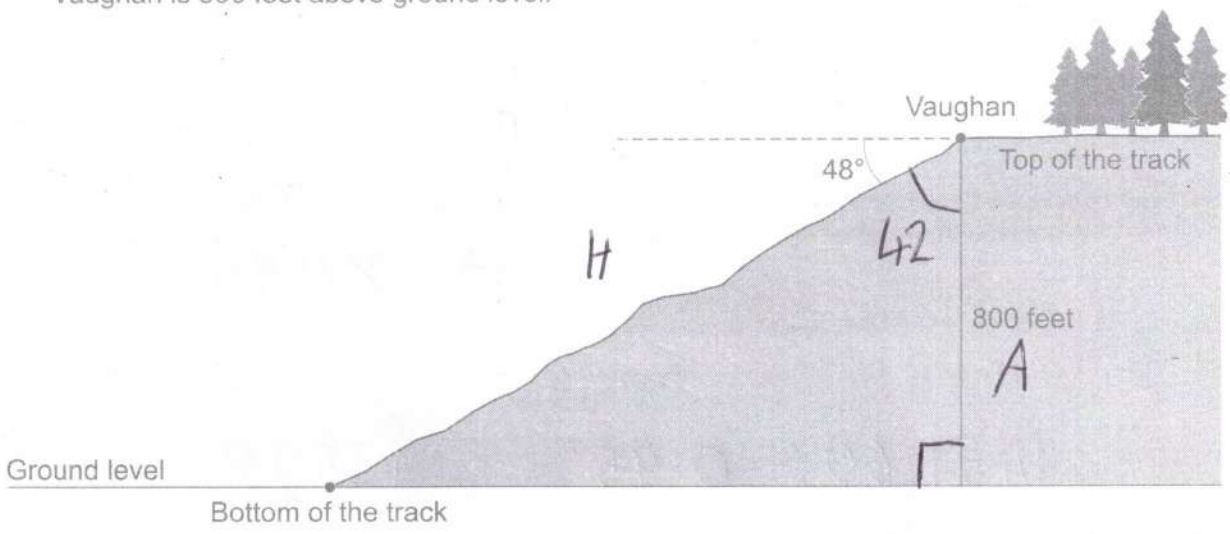


Diagram not drawn to scale

(a) Vaughan cycles from the top of the track to the bottom of the track.
What distance has he cycled? [4]

A
C (H) $H = \frac{800}{\cos 42} = 1076.506...$

The distance Vaughan has cycled is 1076.5 feet.

(b) (i) State an assumption you have made in answering part (a). [1]

He cycles in a direct straight line

(ii) If your assumption is not correct, what effect would this have on your answer to part (a)? [1]

He'd cycle further

Examiner only

8. Bjorn is a jewellery maker.

(a) He pays £1451.60 for a silver bar after a 5% discount has been applied.
What was the original cost of the silver bar? [3]

↳ ×0·95

1451·60 ÷ 0·95 = £1528

(b) The silver bar is in the shape of a cuboid and has the following dimensions:
length 8·1 cm, width 7·3 cm and depth 4 cm.

Bjorn melts down the silver bar and uses the silver to make 200 identical pieces of jewellery.

The density of silver is 10·49 g/cm^3.

Calculate the mass of each piece of jewellery.
Give your answer in grams. [4]

M
D V

V = 8·1 × 7·3 × 4 = 236·52 cm^3

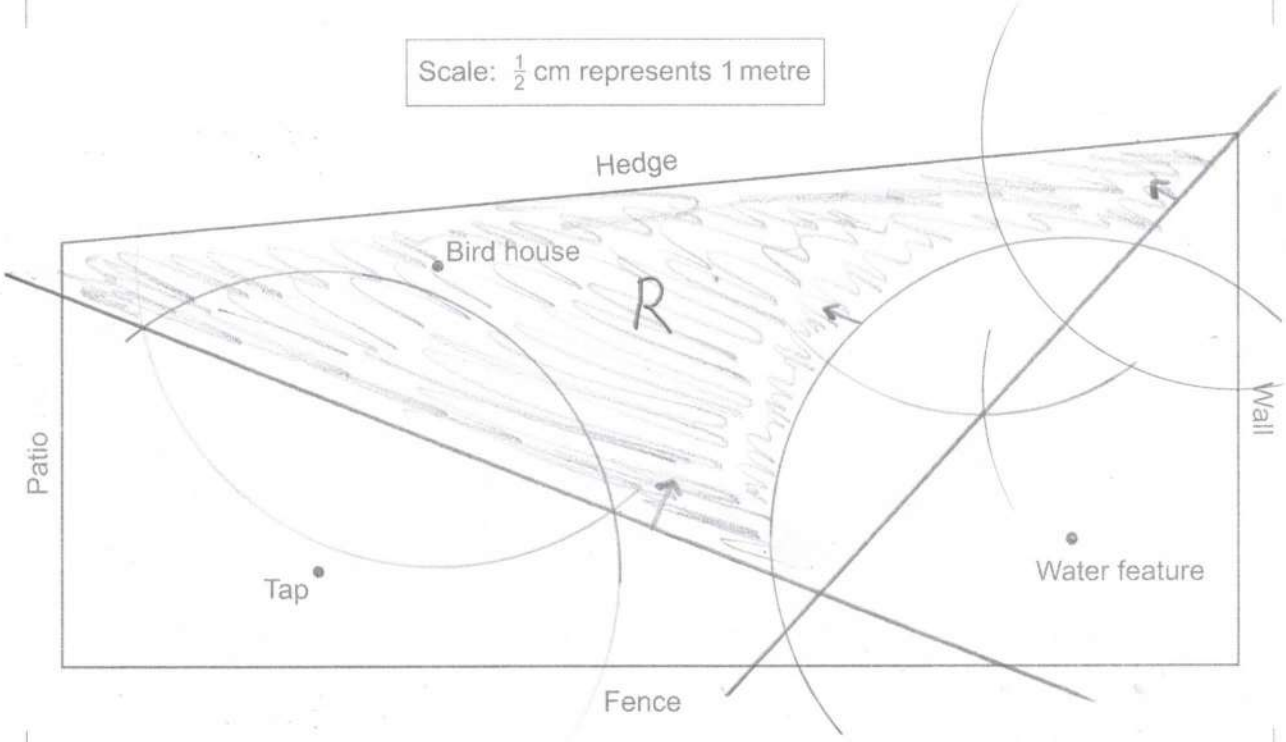
M = 236·52 × 10·49 = 2481·0948

÷200 = 12·405...

Each piece of jewellery has a mass of 12·4 g

Examiner only

9. The diagram below shows a scale drawing of Amy's garden.
The garden is enclosed by a fence, a patio, a hedge, and a wall.
In Amy's garden there is a tap, a bird house and a water feature.



Amy is going to spread grass seed on part of her garden.

The grass seed will be spread over the region that satisfies the following conditions:

- at least 8 metres from the water feature
- nearer to the bird house than the tap
- nearer to the hedge than the wall.

On the diagram, clearly indicate the region that is to be spread with grass seed.
You must use a ruler and a pair of compasses to construct suitable arcs and lines. [6]

1) circle r = 4
2) ⊥ bisector
3) < bisector

Examiner only

10. Make e the subject of the formula. [2]

$$g = 4e - 3f$$

$g + 3f = 4e$

$\frac{g+3f}{4} = e$

11. Some boxes of medicine must be stored on shelves in a refrigerator.

The vertical height between the shelves is 38 cm, **correct to the nearest cm**.

7 identical boxes of medicine are stacked on top of each other on one shelf.

Each box of medicine has a height of 45 mm, **correct to the nearest mm**.

What is the largest possible gap between the top of this stack of boxes and the shelf above? [4]

$38 < \begin{matrix} 38.5 = 385\text{mm} \\ 37.5 = 375\text{mm} \end{matrix}$

$45 < \begin{matrix} 45.5 \\ 44.5 \end{matrix}$

$385 - (7 \times 44.5)$

The largest possible gap is 73.5mm

Examiner only

12. The equation $2x^3 - 3x^2 - 2 = 0$ has only one positive solution.

Akriti says,

Is Akriti correct?

Yes ☐ No ☑

Show calculations and explain your decision. [2]

$f(1.81) = 0.031...$

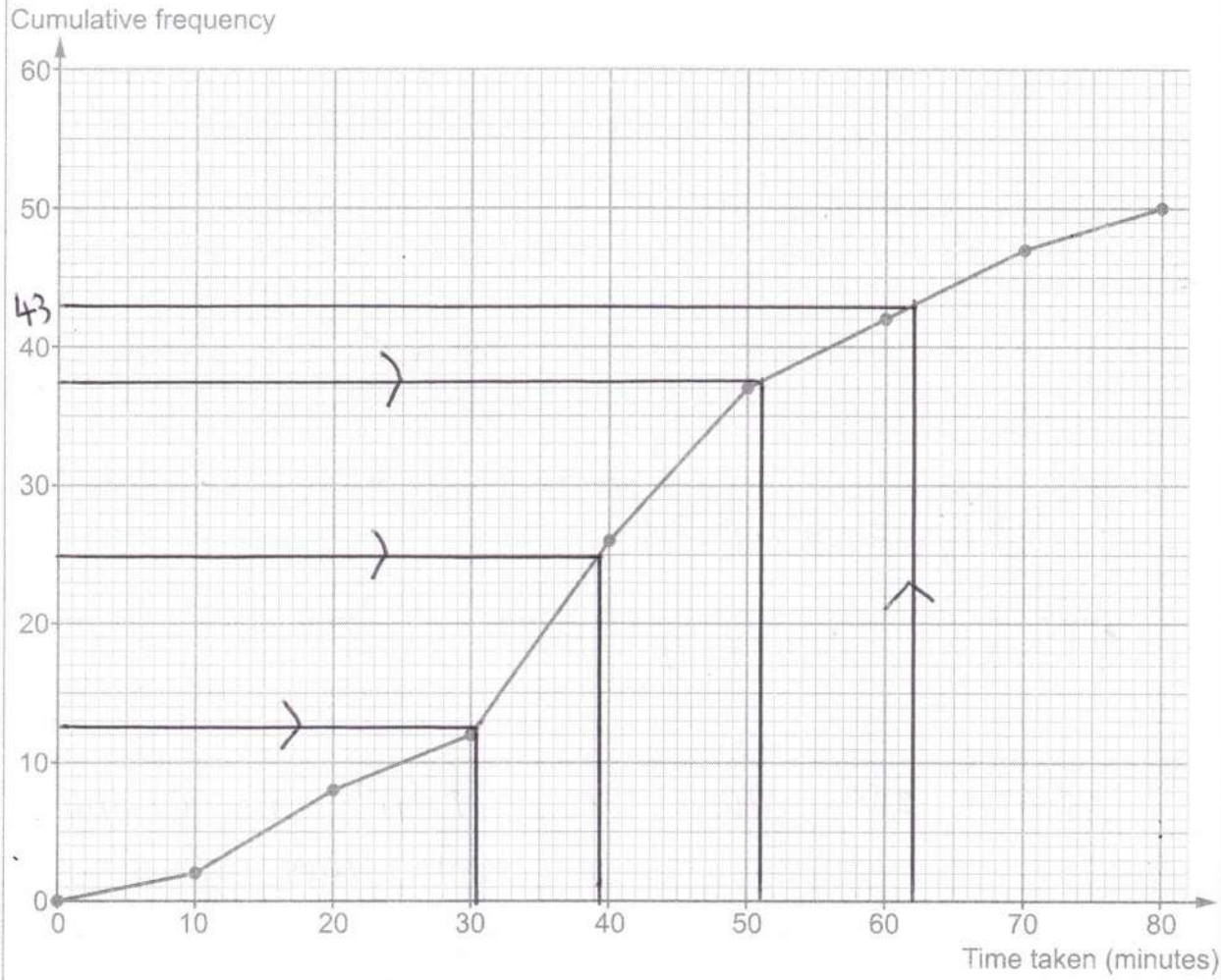
$f(1.82) = 0.119...$

Both are positive, there's no change of sign

Examiner only

13. The same home learning task was given to 50 Year 7 pupils in school A and 50 Year 7 pupils in school B.
The length of time, in minutes, each pupil took to complete the task was recorded.

(a) The results for the pupils from school A are shown on the cumulative frequency diagram below.



Use the cumulative frequency diagram to answer the following questions about the pupils in school A.

(i) What is the median time taken to complete the task? [1]

[ms 39→40]

Median ..39.. minutes

(ii) Calculate the inter-quartile range of the times taken to complete the task. [2]

51 - 31

[ms 19→21]

Inter-quartile range ..20.. minutes

Examiner only

(iii) What percentage of pupils took longer than 62 minutes to complete the home learning task? [2]

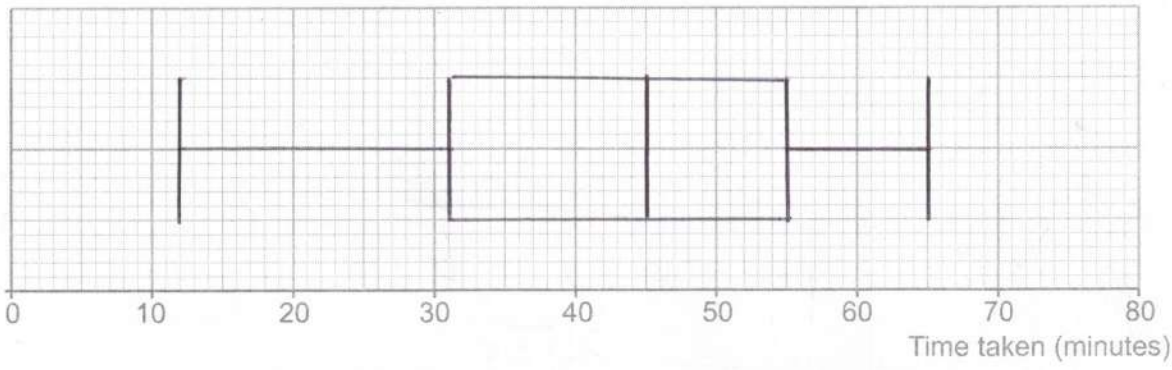
$\frac{7}{50} \times 100 = 14\%$

(b) A summary of the results for the pupils in school B is shown in the table below.

Least time	12 minutes
Lower quartile	31 minutes
Median	45 minutes
Inter-quartile range	24 minutes
Greatest time	1 hour 5 minutes

$31 + 24 = 55$

Draw a box plot to display the results for school B. [3]



(c) Make **two** comments to compare the results of school A and school B.
One comment must include an appropriate average.
The other comment must include a measure of spread. [2]

Comment 1

On average school A was quicker as it had a lower median $39 < 45$

Comment 2

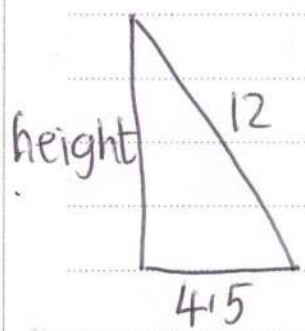
School A's results were the most consistent as they had a lower IQR

Examiner only

14. The diagram below shows a square-based pyramid.
The slant height of each triangular face is 12 cm.

Diagram not drawn to scale

Calculate the volume of the pyramid.
You must show all your working. [5]



$hgt = \sqrt{12^2 - 4{\cdot}5^2}$

$= \frac{3\sqrt{55}}{2}$

$V = \frac{1}{3} \times 9^2 \times \frac{3\sqrt{55}}{2} = 300{\cdot}356\ldots$

Volume = 300·4 cm^3

[ms 299·7 → 300·4]

Examiner only

15. Cody has a bag containing 8 red sweets and 9 green sweets.

Cody randomly selects one sweet at a time and eats it.

(a) Calculate the probability that the first two sweets Cody eats are red. [2]

$$RR = \frac{8}{17} \times \frac{7}{16} = \frac{7}{34}$$

(b) Calculate the probability that the first two sweets Cody eats are the same colour. [2]

$$RR + GG = \frac{7}{34} + \left(\frac{9}{17} \times \frac{8}{16}\right)$$

$$= \frac{8}{17}$$

Examiner only

16. The trapezium shown below has an area of 59·5 cm^2.

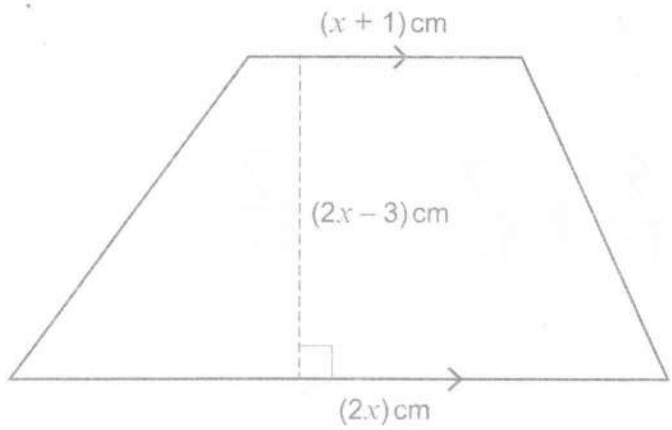


Diagram not drawn to scale

Show that $6x^2 - 7x - 3 = 119$ and hence find the height of the trapezium.
You must show all your working. [6]

Area $= \frac{1}{2}(x+1+2x)(2x-3) = 59.5$

$(3x+1)(2x-3) = 119$

$6x^2 + 2x - 9x - 3 = 119$

$6x^2 - 7x - 3 = 119$ as req^d

$6x^2 - 7x - 122 = 0$

$x = \frac{7 \pm \sqrt{49 + 2928}}{12} = 5.13$ and -3.96

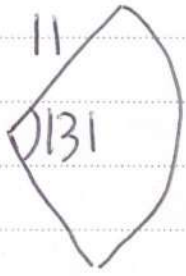
so height $= 2 \times 5.13 - 3$

The height of the trapezium is 7.26 cm

Examiner only

17. Frederick has a circular watch.

(a) The hour hand has a length of 11 mm.
Find the area of the sector covered by the hour hand as it moves through an angle of 131°. [2]



$A = \pi \times 11^2 \times \frac{131}{360} = 138.3\text{mm}^2$

(b) The minute hand of the watch has a length of y mm.

How far does the tip of the minute hand move in 21 minutes? Give your expression in its simplest form in terms of π and y. [2]

$= \frac{126}{360}$

$2 \times \pi \times y \times \frac{126}{360} = \frac{7}{10}\pi y$

Examiner only

18. A car driver is having a tyre replaced at Edutyres Garage.
The waiting time, t minutes, is inversely proportional to the square of the number of mechanics, m, working that day.

If there are 3 mechanics working, the waiting time is 38 minutes.

(a) Find a formula for t in terms of m. [3]

$t = \frac{K}{m^2}$ $38 = \frac{K}{3^2}$

$K = 342$ $t = \frac{342}{m^2}$

(b) The garage wants to reduce the waiting time to no more than 12 minutes.

What is the least number of mechanics that should be working to achieve this? [2]

$m^2 = \frac{342}{t} = \frac{342}{12}$

$m = \sqrt{28.5} = 5.338...$

so 6 mechanics

Examiner only

19.

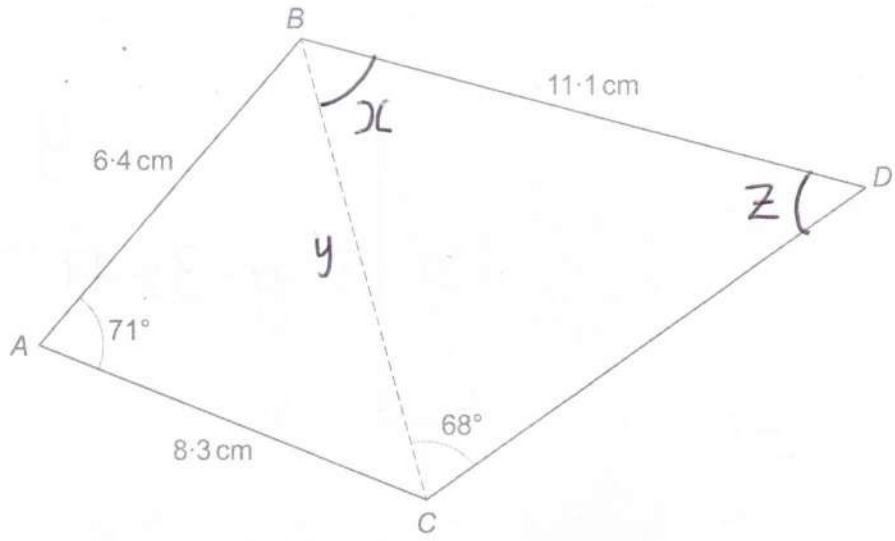


Diagram not drawn to scale

Calculate the size of $C\hat{B}D$. [7]

$y^2 = 6.4^2 + 8.3^2 - 2 \times 6.4 \times 8.3 \times \cos 71$

$y = \sqrt{75.26\ldots} = 8.675\ldots$

$\frac{\sin Z}{8.675} = \frac{\sin 68}{11.1}$

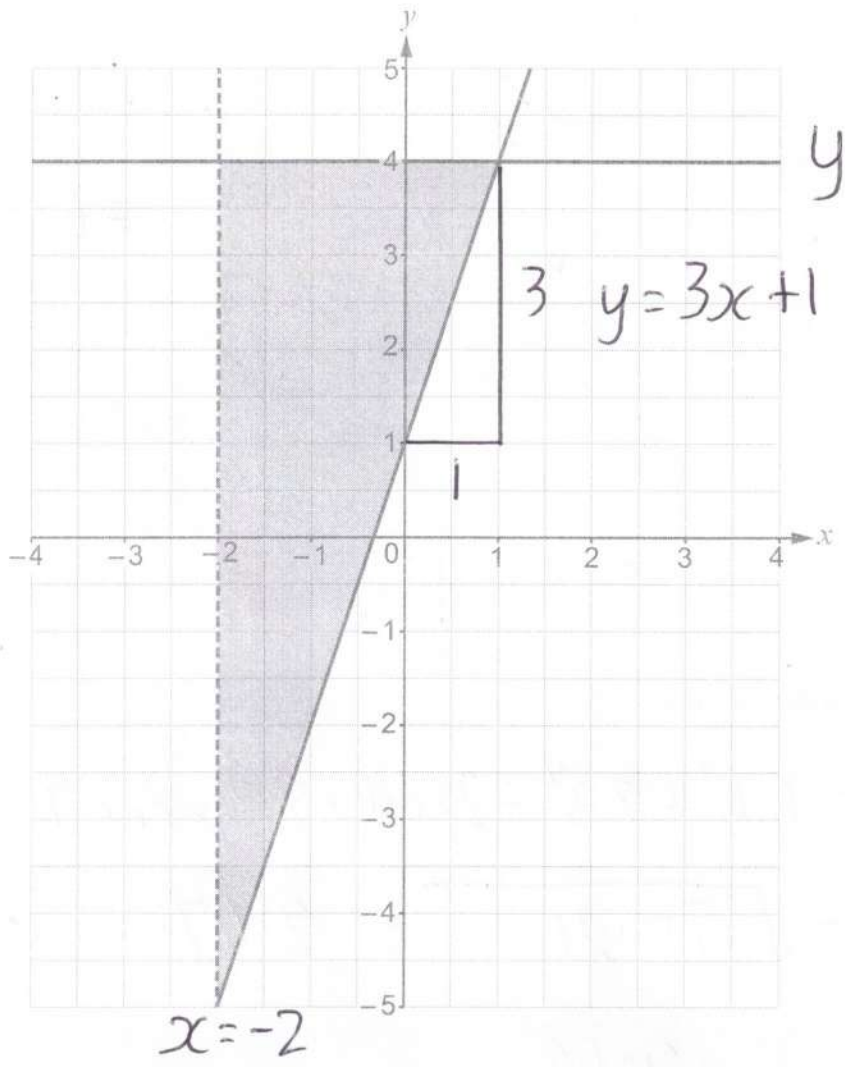
$Z = \sin^{-1}(0.724\ldots) = 46.44$

$x = 180 - 46.44 - 68$

$C\hat{B}D = 65.6$ °

Examiner only

20.



(a) Complete the following table to show the inequalities that describe the shaded region above. [3]

$y \leqslant 4$
$x > -2$
$y \geqslant 3x + 1$

Examiner only

(b) The line AB is shown on the diagram.

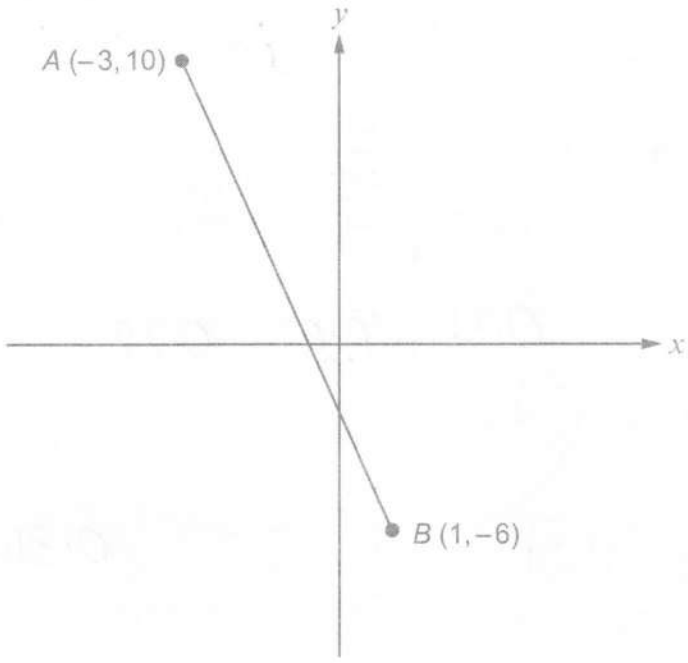


Diagram not drawn to scale

Show that the equation of the perpendicular bisector of the line AB is $4y = x + 9$. [6]

Mid pt $= \left(\frac{-3+1}{2}, \frac{10-6}{2}\right) = (-1, 2)$

$m = \frac{10 - -6}{-3-1} = \frac{16}{-4} = -4$

$m_{\perp} = \frac{1}{4}$

At M: $y = mx + c \Rightarrow 2 = \frac{1}{4} \times -1 + c$

$c = \frac{9}{4}$

so $y = \frac{1}{4}x + \frac{9}{4}$

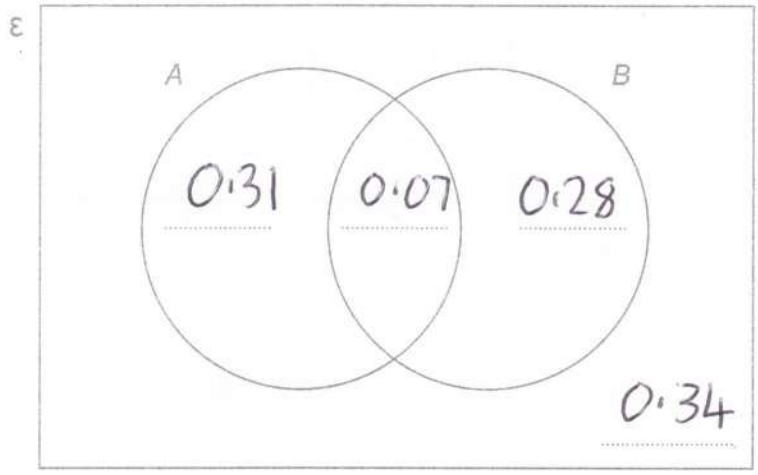
$4y = x + 9$

Examiner only

21. For two events, A and B,

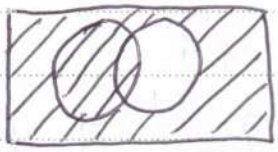
$$P(A \cup B) = 0{\cdot}66,\ P(A \cap B) = 0{\cdot}07 \text{ and } P(A \cap B') = 0{\cdot}31$$

(a) By completing the Venn diagram or otherwise, find the probability that B occurs and A does not occur. [3]



The probability that B occurs and A does not occur is 0·28

(b) Find $P(A \cup B')$. [2]



$= 1 - 0{\cdot}28$

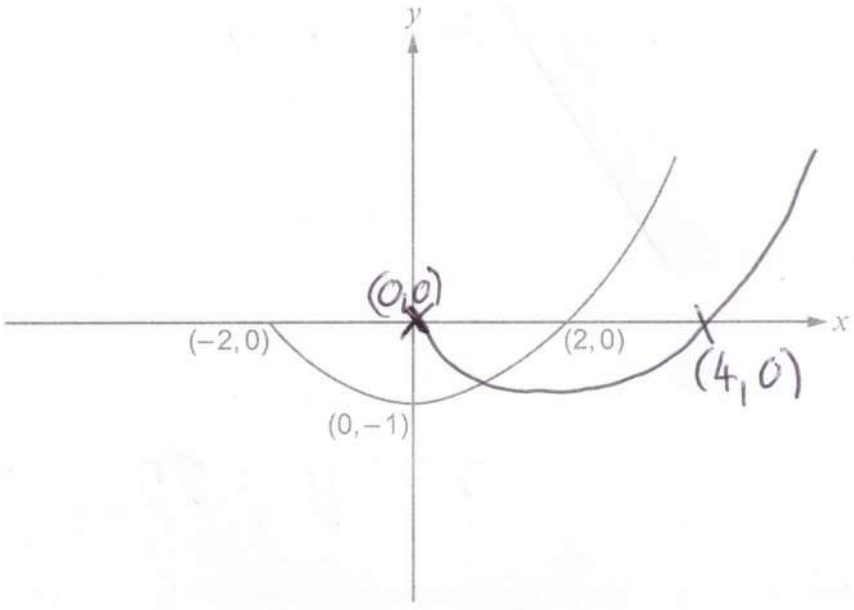
$= 0{\cdot}72$

Examiner only

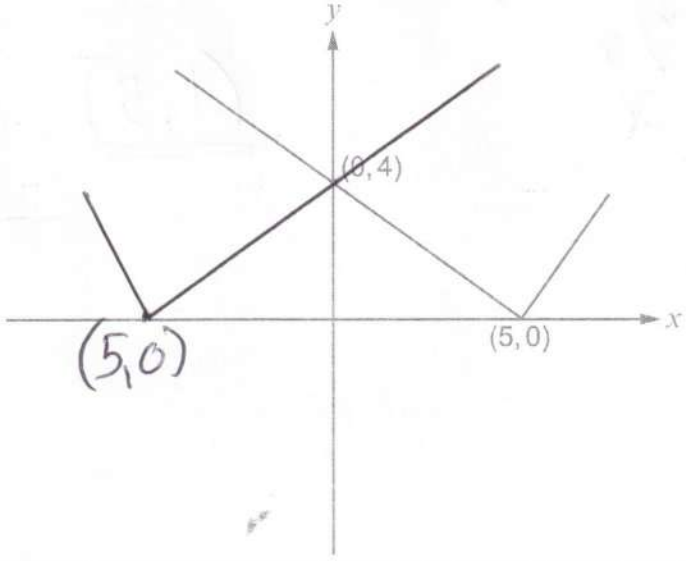
22. (a) Write $y = x^2 - 4x - 1$ in the form $y = (x+a)^2 + b$, where a and b are constants. [2]

$= (x-2)^2 - 4 - 1$ $= (x-2)^2 - 5$

(b) (i) The diagram below shows a sketch of $y = f(x)$. $\rightarrow 2$
On the same diagram, sketch $y = f(x-2)$.
Mark clearly the coordinates of any intercepts with the axes. [2]

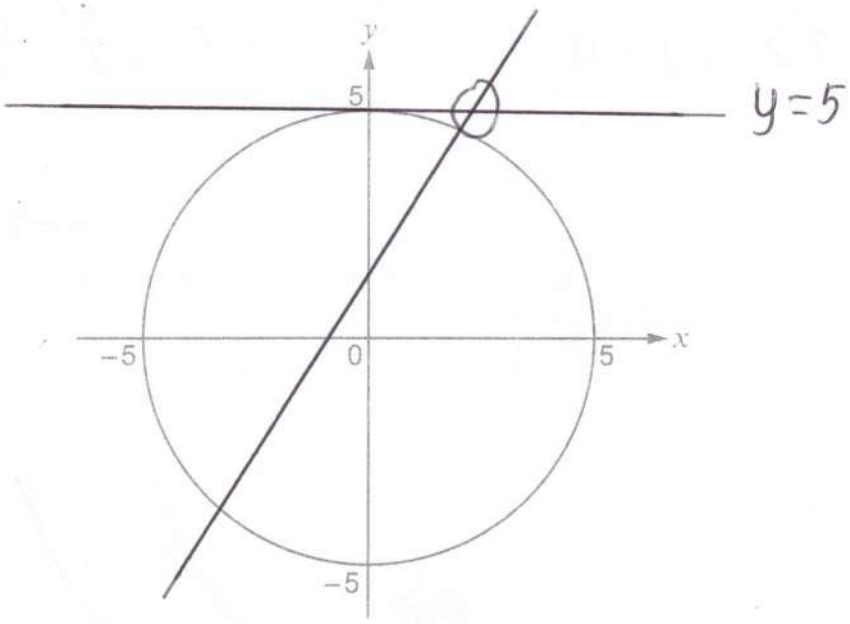


(ii) The diagram below shows a sketch of $y = g(x)$. ref y-axis
On the same diagram, sketch $y = g(-x)$.
Mark clearly the coordinates of any intercepts with the axes. [2]



Examiner only

23. The graph below shows a circle centred at the origin.



(a) Write down the equation of the circle shown on the graph above. [1]

$x^2 + y^2 = 25$

(b) Find the coordinates of the point of intersection of the tangent to the circle above at (0,5) and the line $y = 2x + 3$. [2]

$5 = 2x + 3$

$2 = 2x$

$1 = x$

(1,5)

END OF PAPER