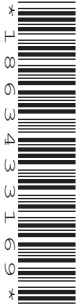


Thursday 15 May 2025 – Morning**GCSE (9–1) Mathematics****J560/04 Paper 4 (Higher Tier)****Time allowed: 1 hour 30 minutes****You must have:**

- the Formulae Sheet for Higher Tier (inside this document)

You can use:

- a scientific or graphical calculator
- geometrical instruments
- tracing paper

Please write clearly in black ink. **Do not write in the barcodes.**

Centre number

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Candidate number

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First name(s)

Last name

INSTRUCTIONS

- Use black ink. You can use an HB pencil, but only for graphs and diagrams.
- Write your answer to each question in the space provided. You can use extra paper if you need to, but you must clearly show your candidate number, the centre number and the question numbers.
- Answer **all** the questions.
- Where appropriate, your answer should be supported with working. Marks might be given for using a correct method, even if your answer is wrong.
- Use the π button on your calculator or take π to be 3.142 unless the question says something different.

INFORMATION

- The total mark for this paper is **100**.
- The marks for each question are shown in brackets [].
- This document has **20** pages.

ADVICE

- Read each question carefully before you start your answer.

Please note that these worked solutions have neither been provided nor approved by OCR and may not necessarily constitute the only possible solutions. Please refer to the original mark schemes for full guidance.

Any writing in blue should be written in the exam.

Anything written in green in a rectangle doesn't have to be written in the exam.

If you find any mistakes or have any requests or suggestions, please send an email to curtis@cgmaths.co.uk

1 Calculate.

$$\frac{4.5^3}{1.8} + \frac{3.6}{2.4^2}$$

Give your answer correct to 3 significant figures.

Typing it into the calculator exactly as it is above gives 51.25, which is 51.3 to 3 significant figures

51.3

[2]

2 The ratio 40 grams to 1 kilogram can be written in the form 1 : n .

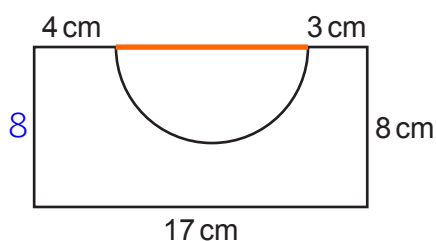
Find the value of n .

$$1000 \div 40$$

1 kilogram = 1000 grams. So the ratio is 40 : 1000.
Dividing both sides by 40 gets 1 on the left

$n = 25$ [2]

3 The diagram shows a shape formed from a rectangle measuring 8 cm by 17 cm with a semicircle removed from one side.



Not to scale

Calculate the perimeter of the shape.

$$17 - 4 - 3$$

Subtracting the 4 cm and 3 cm from the 17 cm finds that the diameter of the semicircle (the orange line) is 10 cm

$$\frac{\pi \times 10}{2}$$

Circumference = $\pi \times$ diameter. The arc of the semicircle is half of the circumference. So the arc of the semicircle is 5π cm

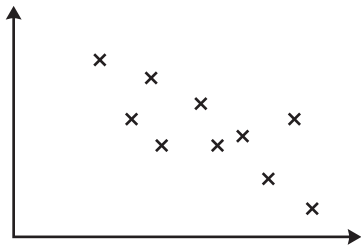
$$5\pi + 3 + 8 + 17 + 8 + 4$$

Adding all the outside sides gives the perimeter

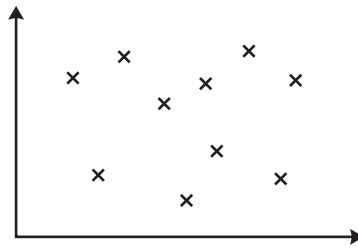
55.7

cm [4]

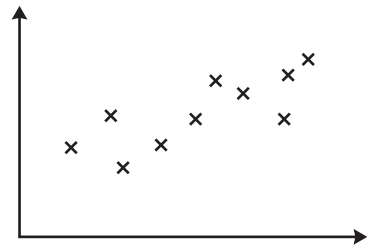
- 4 (a) Describe the correlation shown in each of these scatter diagrams.



Negative



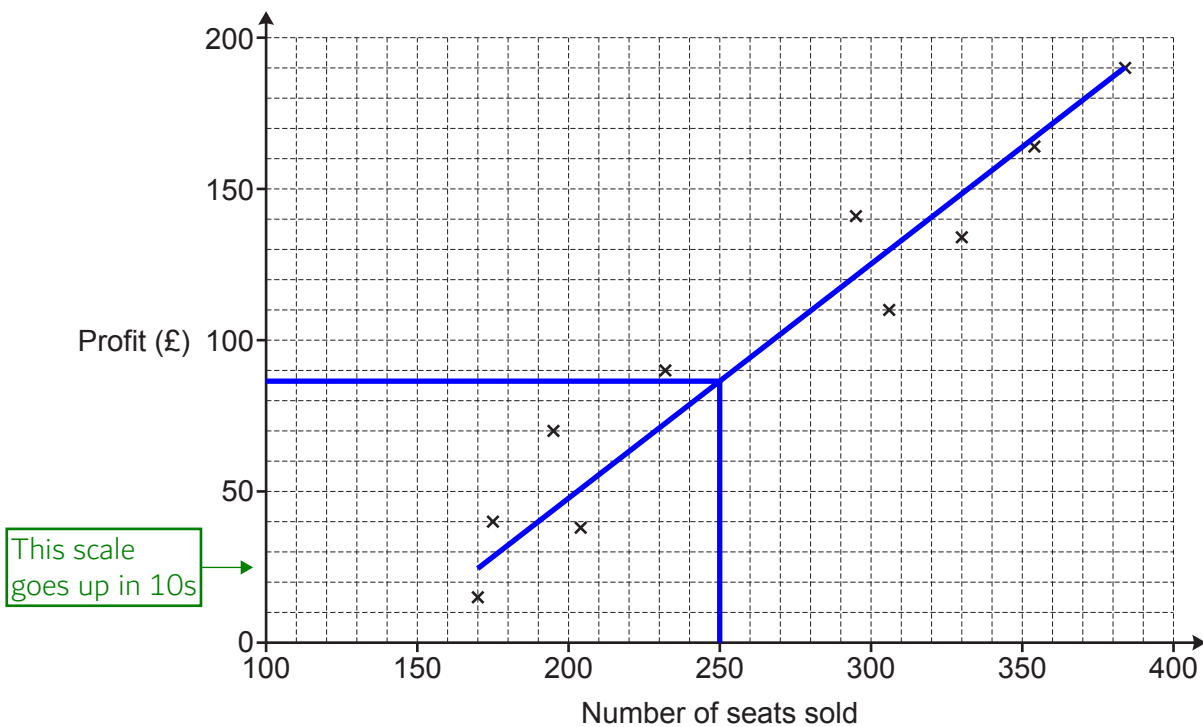
None



Positive

[2]

- (b) A theatre records the number of seats sold and the profit made for 10 performances. The scatter diagram shows these results.



By drawing a line of best fit, estimate the profit made when 250 seats are sold.

Drawing a line of best fit using a clear ruler. Drawing in the same direction as the trend of the points and trying to get the same number of points above and below the line. Reading up from 250 to the line and across to the profit to estimate the profit. To the nearest half a box, it is £85

(b) £ 85 [2]

Both sides are equivalent. It is true for all values of x

- 5 (a) For each of the algebraic statements below decide whether it is an equation or an identity.

Only true for some values of x . Can be solved

$$(x-1)(x-2) = 12$$

is an Equation

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

is an Identity

Expanding this gives the same as the right

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

is an Equation

[1]

- (b) A straight line is parallel to $y = 3x$ and passes through the point (2, 11).

Find the equation of the line in the form $y = mx + c$.

$$11 = 3(2) + c$$

The general equation of a straight line is $y = mx + c$, where m is the gradient and c is the y -intercept. The gradient of $y = 3x$ is 3, so the gradient of the line parallel to this must also have gradient of 3. Substituting in the x and y -coordinate of (2, 11)

$$c = 5$$

Subtracting $3(2)$ from both sides gets x on its own

It is parallel so has the same gradient of 3, so m is 3. $c = 5$

(b) $y = 3x + 5$ [3]

- 6 The distance of a car race is 420 km.
A car completes the first 210 km at an average speed of 150 km/h.
The same car completes the final 210 km at an average speed of 100 km/h.

Show that the average speed of the car for the whole race is less than 125 km/h.

[5]

$\begin{matrix} d \\ s \quad t \end{matrix}$

Writing a formula triangle for distance, speed, time

$$210 \div 150 = 1.4$$

Covering t finds that time = distance $\div$ speed. So the time for the first 210 km is 1.4 hours, as hours was in the unit of speed

$$210 \div 100 = 2.1$$

Covering t finds that time = distance $\div$ speed. So the time for the final 210 km is 2.1 hours, as hours was in the unit of speed

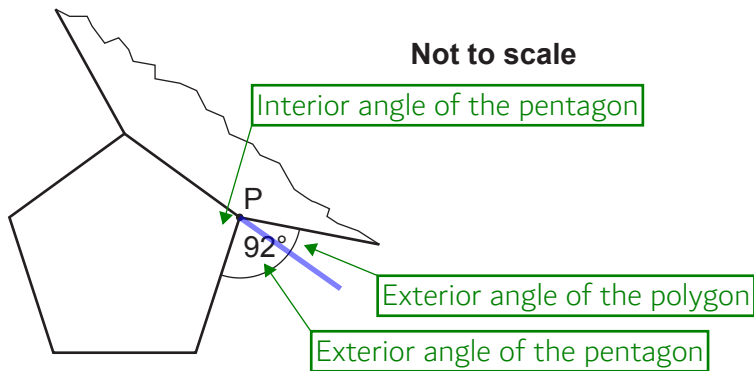
$$1.4 + 2.1$$

Adding the 1.4 hours for the first 210 km and the 2.1 hours for the final 210 km finds that the total time is 3.5 hours

$$420 \div 3.5 = 120$$

Covering s finds that speed = distance $\div$ time. So dividing the total 420 km by the total 3.5 hours finds that the average speed is 120 km/h, which is less than 125 km/h

- 7 The diagram shows a regular pentagon and part of another regular polygon meeting at point P. One of the angles at point P is 92° .



- (a) Show that the size of one interior angle of a regular pentagon is 108° .

[2]

$$360 \div 5 = 72$$

The exterior angles of any polygon all add up to 360° . So dividing 360° by the 5 exterior angles of a regular pentagon finds that each exterior angle is 72°

$$180 - 72 = 108$$

The interior and exterior angles lie around a point on a straight line so must add up to 180° . Subtracting the exterior angle from 180° shows that the interior angle of the regular pentagon is 108°

- (b) Find the number of sides of the other regular polygon.

$$92 - 72$$

Subtracting the exterior angle of the regular pentagon from the 92° finds that the exterior angle of the polygon is 20°

$$360 \div 20$$

The exterior angles of any polygon all add up to 360° . So dividing 360° by the 20° of each exterior angle finds that there are 18 exterior angles. So there must be 18 sides

(b) 18 [4]

- 8 A town council are going to do a survey on how people travel to work or school and for how long they travel.

One day their interviewer stands outside the town railway station and chooses 20 people at random to form their sample.

Make **three different** criticisms or suggestions for improving the council's method for selecting their sample.

- 1 Only one day ← Doing a longer period of time will get more reliable results
- 2 Biased location ← People outside of the town railway station are more likely to be using train. There are other methods of travel such as walking or bus
- 3 Small sample ← Asking more than 20 people will get more reliable results

[3]

- 9 (a) Write 0.0037 in standard form.

Multiplying 0.0037 by ten 3 times gives 3.7, which is at least 1 and less than 10. Multiplying 3.7 by 10^{-3} means to divide by ten 3 times so keeps it equal

(a) 3.7×10^{-3} [1]

- (b) A country consists of a south island and a north island.
The table below shows the population and area of each island in June 2023.

	Population	Area (km ²)
South island	1.2×10^6	1.5×10^5
North island	4.0×10^6	1.1×10^5

Work out the overall population density of the country in June 2023.

$$\frac{1.2 \times 10^6 + 4.0 \times 10^6}{1.5 \times 10^5 + 1.1 \times 10^5}$$

People per km² means to divide the number of people (population) by the area in km². Adding the two populations gives the total population of the country and adding the two areas gives the total area of the country

(b) 20 people per km² [4]

- 10 Find the value of k .

$$\frac{25 \times (5^3)^k}{5^4} = 5^{19}$$

$$5^2 \times 5^{3k} = 5^{23}$$

Multiplying both sides by 5^4 eliminates the denominator on the left. $5^{19} \times 5^4 = 5^{19+4} = 5^{23}$.
Expressing 25 as 5^2 so that it is 5 to the power of something. $(5^3)^k = 5^{3 \times k} = 5^{3k}$

$$5^{3k} = 5^{21}$$

Dividing both sides by 5^2 eliminates it on the left. $5^{23} \div 5^2 = 5^{23-2} = 5^{21}$

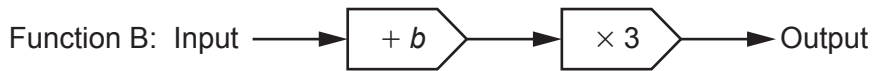
$$3k = 21$$

The power on the left must be equal to the power on the right as both sides are 5 to the power of something

Dividing both sides by 3 gets k on its own

$k =$ 7 [3]

11 Function A and function B are shown below.



When the input for both machines is 11, the output of Function A is equal to the output of Function B.

When the input for both machines is 29, the output of Function A is twice the output of Function B.

Find the value of a and the value of b .

$11 - 5$ $\longleftarrow$ Putting the input of 11 into Function A. The first step gives 6

$6 \times a$ $\longleftarrow$ Applying the second step of Function A gives an output of $6a$

$(11 + b) \times 3$ $\longleftarrow$ Putting the input of 11 into Function B

$6a = 33 + 3b$ $\longleftarrow$ Expanding the brackets to give the output of $33 + 3b$ and setting the output of Function A equal to this. This forms the 1st equation

$29 - 5$ $\longleftarrow$ Putting the input of 29 into Function A. The first step gives 24

$24 \times a$ $\longleftarrow$ Applying the second step of Function A gives an output of $24a$

$(29 + b) \times 3 \times 2$ $\longleftarrow$ Putting the input of 29 into Function B. Multiplying it all by 2 to make it equal to the output of Function A, as the output of Function A is twice the output of Function B

$24a = 174 + 6b$ $\longleftarrow$ Expanding the brackets and setting the output of Function A equal to this. This forms the 2nd equation

$12a = 66 + 6b$ $\longleftarrow$ Multiplying all terms on both sides of the 1st equation by 2 to get the same number of b as the 2nd equation. This forms the 3rd equation

$12a = 108$ $\longleftarrow$ Subtracting the 3rd equation from the 2nd equation cancels out the b term and gives an equation just in terms of a . Then dividing both sides by 12 finds that $a = 9$

$54 = 33 + 3b$ $\longleftarrow$ Substituting 9 for a in the 1st equation

$21 = 3b$ $\longleftarrow$ Subtracting 33 from both sides. Then dividing both sides by 3 finds that $7 = b$

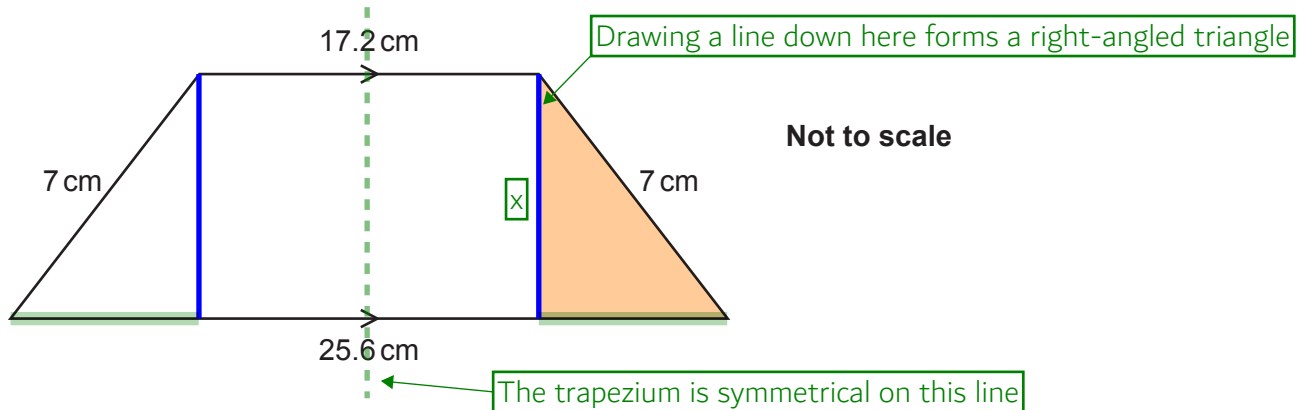
$$a = \dots\dots\dots 9$$

$$b = \dots\dots\dots 7$$

[5]

Turn over

12 The diagram shows a trapezium.



Calculate the area of the trapezium.
You must show your working.

$$25.6 - 17.2$$

Subtracting the 17.2 cm from the 25.6 cm finds that the two parts of the line highlighted in green are 8.4 cm in total

$$8.4 \div 2$$

As the shape is symmetrical, the two parts of the line highlighted in green are equal. So dividing their total by 2 finds that one of the parts highlighted in green is 4.2 cm. This is the base of the orange right-angled triangle

$$x^2 + 4.2^2 = 7^2$$

Using Pythagoras' Theorem in the orange right-angled triangle to find the missing side. $a^2 + b^2 = c^2$, where a and b are the shorter sides and c is the longest side

$$x^2 = 31.36$$

Subtracting the 4.2^2 from both sides gets the x^2 on its own

$$x = 5.6$$

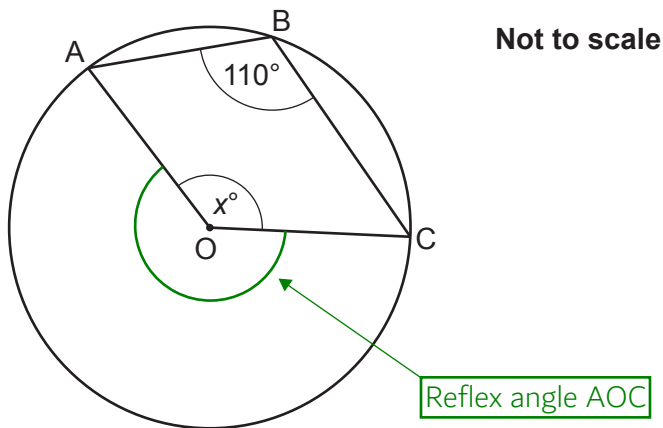
Square rooting both sides gets x on its own and finds that it is 5.6 cm. This is the height of the trapezium

$$\frac{1}{2}(17.2 + 25.6) \times 5.6$$

Area of trapezium = $\frac{1}{2}(a + b)h$, where a and b are the parallel sides and h is the perpendicular distance between them

$$\dots\dots\dots 119.84 \dots\dots\dots \text{cm}^2 \quad [5]$$

- 13 A, B, and C are points on a circle, centre O.



- (a) Explain why OABC is **not** a cyclic quadrilateral.

O is not on the circumference

Cyclic quadrilaterals are four-sided shapes with all four corners on the circumference of a circle

[1]

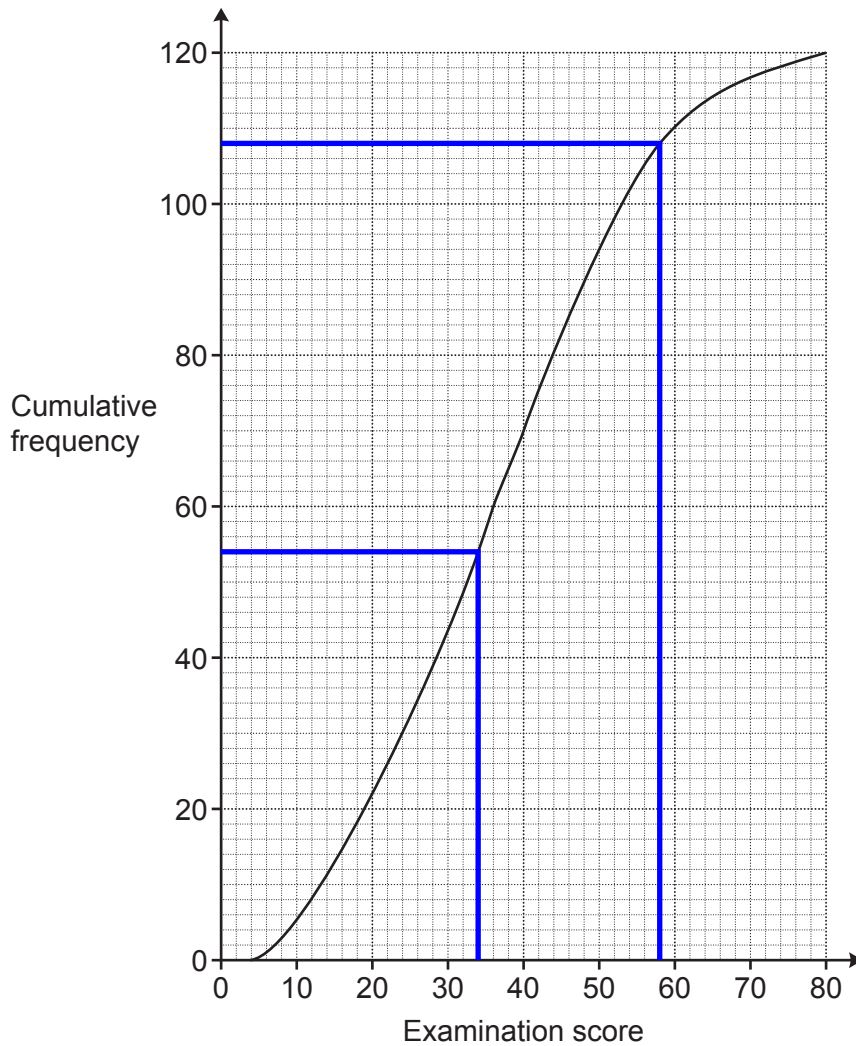
- (b) Work out the value of x .

110×2 ← Angle at the centre is double the angle at the circumference. So reflex angle AOC is 220°

$360 - 220$ ← Angles around a point add up to 360° . So subtracting reflex angle AOC from 360° finds that x is 140°

$x = 140$ [2]

- 14 The cumulative frequency graph shows the distribution of the examination scores for 120 students.



- (a) A student says that they had an examination score of 34 and so were in the top half of the 120 students.

Is the student correct?

Give a reason for your decision.

$$120 \div 2 = 60$$

Dividing the 120 students by 2 finds that the top half of the students is above the 60th student when put in order

No because 54 is less than half of 120

Reading up from the score of 34 to the line and across finds that the cumulative frequency is 54 for this score. So the score of 34 is estimated to be the 54th student when put in order, which is below the 60th student

[2]

(b) The top 10% of the 120 students are awarded a commendation.

Find the minimum mark required for a commendation.

$$\frac{10}{100} \times 120$$

Putting the 10% over 100 converts it to a fraction, which when multiplied by the 120 finds that 10% of the 120 is 12

$$120 - 12 = 108$$

Subtracting the value of 10% from the 120 students finds that the 108th student would have the lowest mark to be in the top 10%

Drawing a line across from 108 to the line then down estimates that the minimum mark of the top 10% is 58

(b) 58 [3]

15 y is inversely proportional to the square of x .
 $y = 5$ when $x = 6$.

Find a formula linking x and y .

$$y \propto \frac{1}{x^2}$$

Writing the proportion

$$y = \frac{k}{x^2}$$

Multiplying the right side of the proportion by k (which represents an unknown constant) to convert it into an equation

$$5 \times 6^2 = k$$

Multiplying both sides by x^2 gets k on its own.
 Substituting 5 for y and substituting 6 for x . So k is 180

Substituting 180 for k in the original equation

$$y = \frac{180}{x^2}$$

..... [3]

- 16 The population of fish, P , in a pond is predicted by the formula

$$P = 640 \times 1.025^n$$

where n is the number of years after 1st January 2020.

- (a) Write down the population of fish on 1st January 2020.

$n = 0$ as the number of years after the 1st January 2020 is 0 on the 1st January 2020. Anything to the power of 0 is 1, so it becomes $P = 640 \times 1$

(a) 640 [1]

- (b) Write down the percentage increase per year used in the formula.

The multiplier each year is 1.025. Multiplying this by 100 converts it to 102.5% then subtracting the original 100% finds that the increase is 2.5%

(b) 2.5 % [1]

- (c) (i) Show that the formula predicts that the population of fish will reach 1000 between 1st January 2038 and 1st January 2039. [3]

$$2038 - 2020$$

Subtracting the year 2020 from the year 2038 finds that the 1st January 2038 is 18 years after the 1st January 2020. So $n = 18$ for 1st January 2038

$$640 \times 1.025^{18} = 998$$

Substituting 18 for n finds that the predicted population on 1st January 2038 is 998, which is less than 1000

$$640 \times 1.025^{19} = 1023$$

Substituting 19 for n finds that the predicted population on 1st January 2039 is 1023, which is more than 1000

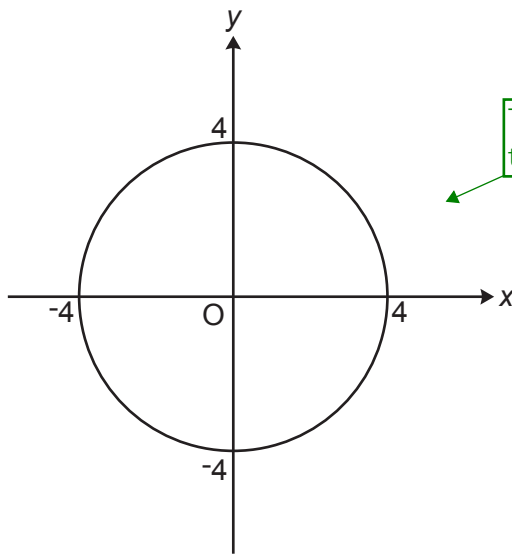
So the population must reach 1000 some time between 1st January 2038 and 1st January 2039 as it is continually increasing according to the prediction

- (ii) Give **one** reason why this might not happen.

The rate of increase may not continue

... There may be physical limits for the population of the fish such as the size of the pond which prevents the population from growing forever [1]

17 The diagram shows a circle, centre (0,0).



The radius is 4 as this is the distance from the centre to the outside of the circle

(a) Write down the equation of the circle.

The general equation of a circle with its centre at the origin is $x^2 + y^2 = \text{radius}^2$

(a) $x^2 + y^2 = 4^2$ [2]

(b) Point A has coordinates (2.3, 3.3).

Show that point A does **not** lie on the circle and state, with a reason, whether it lies inside the circle or outside the circle.

$$2.3^2 + 3.3^2$$

Substituting the x and y-coordinate into the equation $x^2 + y^2 = \text{radius}^2$ to find that $\text{radius}^2 = 16.18$

$$\sqrt{16.18} = 4.02...$$

Square rooting the radius^2 finds that the radius would be 4.02... which is greater than the radius of 4 so must be on the outside of the circle

Point A lies **outside** the circle because **it would lie on a circle with radius greater than 4** [3]

18 (a) A sequence is defined by

$$u_{n+1} = ku_n - 2, u_2 = 7 \text{ and } u_3 = 29.5.$$

Find the value of k .

$$29.5 = 7k - 2 \quad \leftarrow \text{Substituting } u_3 \text{ for } u_{n+1} \text{ and substituting } u_2 \text{ for } u_n$$

$$31.5 = 7k \quad \leftarrow \text{Adding 2 to both sides to get the } k \text{ term on its own}$$

Dividing both sides by 7 gets k on its own

$$(a) \quad k = \dots\dots\dots 4.5 \quad [3]$$

(b) Another sequence is defined by $u_{n+1} = 6u_n - 7$.

(i) Find the value of u_1 in the case when $u_2 = 2 \times u_1$.

$$2x = 6x - 7 \quad \leftarrow \text{Let } x \text{ be } u_1. u_2 \text{ would be } 2x. \text{ Substituting } 2x \text{ for } u_{n+1} \text{ and substituting } x \text{ for } u_n$$

$$-4x = -7 \quad \leftarrow \text{Subtracting } 6x \text{ from both sides to get all the } x \text{ on the same side}$$

Dividing both sides by -4 gets x on its own. x was u_1

$$(b)(i) \quad u_1 = \dots\dots\dots 1.75 \quad [2]$$

(ii) Explain what happens to the sequence $u_{n+1} = 6u_n - 7$ when $u_1 = 1.4$.

$$6(1.4) - 7 = 1.4$$

Stays the same $\leftarrow$ Substituting 1.4 for u_n finds that u_{n+1} would be 1.4. This means that the sequence will just keep repeating 1.4 as 1.4 will keep being substituted in to get 1.4

.....
 [1]

19 Multiply out and simplify.

$$(\sqrt{5} + 1)(\sqrt{15} - \sqrt{3})$$

Give your answer in the form $a\sqrt{b}$, where a and b are integers.

You must show each step in your working.

$$\sqrt{75} - \sqrt{15} + \sqrt{15} - \sqrt{3} \leftarrow \text{Expanding the brackets. } \sqrt{5} \times \sqrt{15} = \sqrt{5 \times 15} = \sqrt{75}. \sqrt{5} \times \sqrt{3} = \sqrt{5 \times 3} = \sqrt{15}$$

$$\sqrt{25}\sqrt{3} \leftarrow \text{Simplifying } \sqrt{75} \text{ by expressing it as the square root of a square number multiplied by another square root}$$

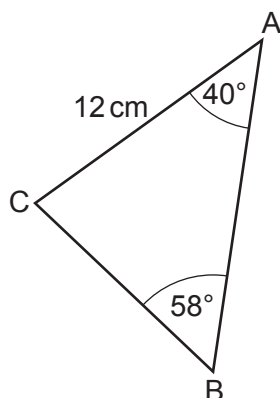
$$5\sqrt{3} - \sqrt{3} \leftarrow \sqrt{25} = 5. \text{ So } \sqrt{75} = 5\sqrt{3}. \text{ The } -\sqrt{15} \text{ and } +\sqrt{15} \text{ cancel out}$$

$$5x - x = 4x, \text{ so } 5\sqrt{3} - \sqrt{3} = 4\sqrt{3}$$

$$4\sqrt{3}$$

[3]

20 The diagram shows triangle ABC.



Not to scale

AC = 12 cm, angle CAB = 40° and angle ABC = 58° .

Calculate length BC.

$$\frac{BC}{\sin 40} = \frac{12}{\sin 58} \leftarrow \frac{a}{\sin A} = \frac{b}{\sin B} \leftarrow \text{Using the sine rule. Side a is opposite angle A and side b is opposite angle B}$$

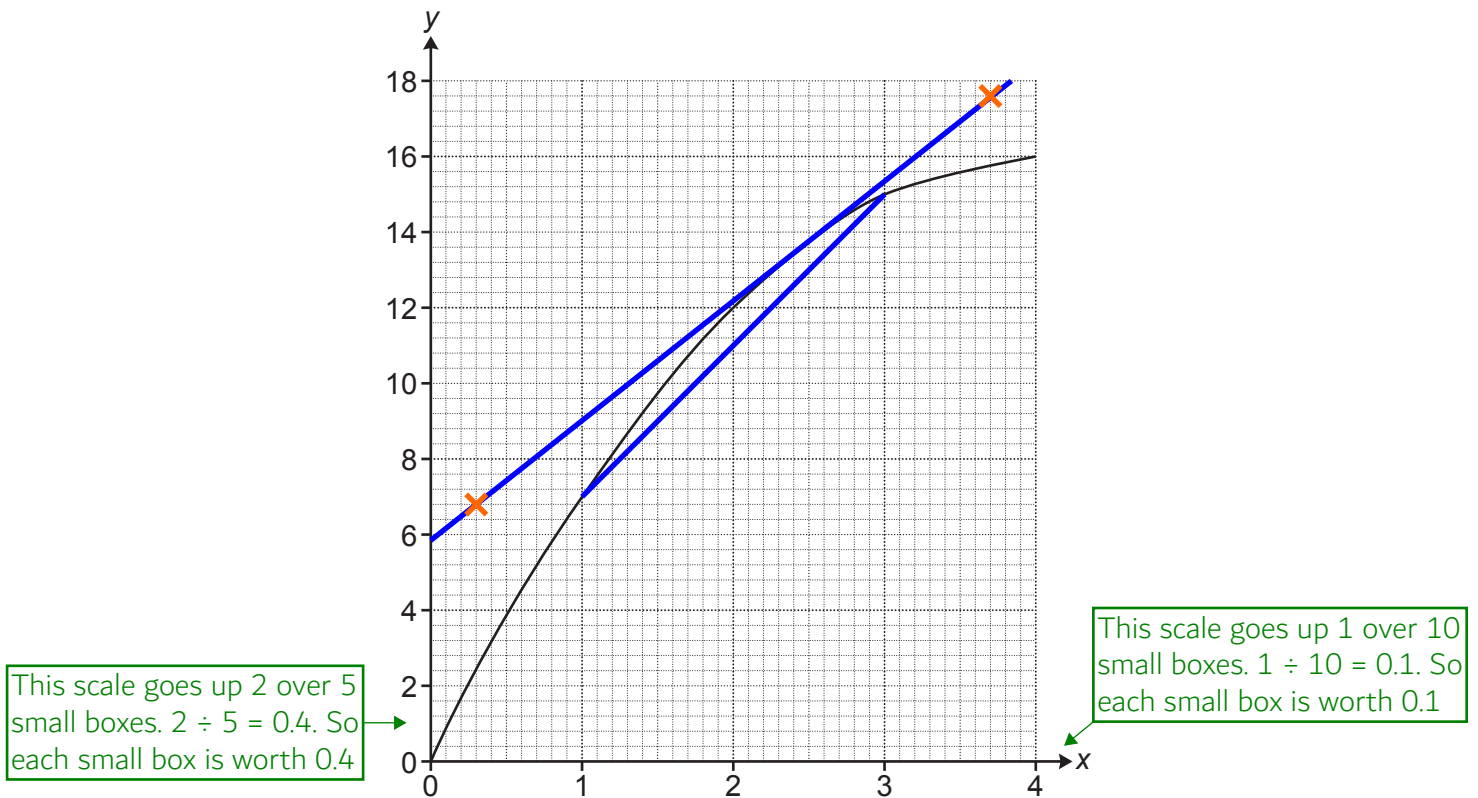
$$\text{Multiplying both sides by } \sin 40 \text{ gets BC on its own}$$

$$9.1$$

cm [3]

Turn over

21 The graph of a function is drawn on the grid for $0 \leq x \leq 4$.



(a) Work out the average rate of change of the function between $x = 1$ and $x = 3$.

$$\frac{15 - 7}{3 - 1}$$

Drawing a straight line between the two points on the curve where $x = 1$ and $x = 3$ and finding its gradient finds the average rate of change between $x = 1$ and $x = 3$. Gradient = rise/run. It rises from 7 to 15 and runs from 1 to 3

(a) 4..... [2]

(b) Use the graph to estimate the gradient of the function at $x = 2.5$.
You must show working to support your estimate.

$$\frac{17.4 - 6.8}{3.7 - 0.3}$$

Drawing a tangent at $x = 2.5$ on the curve. Gradient = rise/run. Using the two orange points, it rises from 6.8 to 17.4 and runs from 0.3 to 3.7

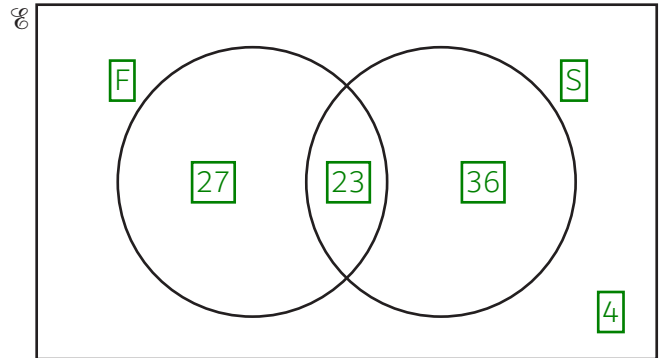
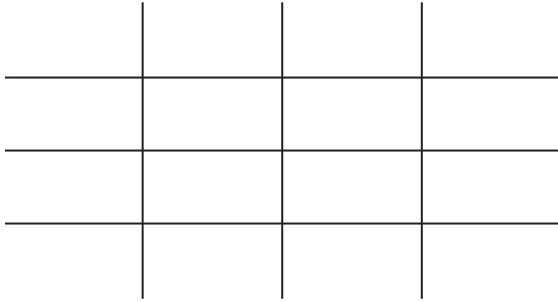
(b) 3.1..... [4]

22 A school has 90 students in Year 11.

- 50 of the students study French.
- 59 of the students study Spanish.
- 4 of the students do not study either of these languages.

One the students is chosen at random.

Find the probability that the student studies French given that they study Spanish.
You may use the grid **or** the Venn diagram to help present your working if you wish.



$50 + 59 + 4$ ← Adding the 50 who study French, the 59 who study Spanish and the 4 who study neither finds that there would be 113 students in total if there was no overlap between the French and Spanish students

$113 - 90$ ← Every 1 student put in the overlap between the French and Spanish students takes 1 off the total. Finding the difference between the 113 and the 90 students finds that 23 needs to go into the overlap

Out of the 59 students who study Spanish, 23 also study French

$$\frac{23}{59}$$

[5]

Turn over for question 23

- 23 (a) Write this expression in its simplest factorised form.

$$(x + 4)(x - 4)^2 - x^2(x - 5)$$

You must show your working.

$$(x - 4)(x - 4) \leftarrow \text{Writing out the } (x - 4)^2 \text{ as two brackets multiplied together}$$

$$x^2 - 4x - 4x + 16 \leftarrow \text{Expanding the } (x - 4)(x - 4)$$

$$(x + 4)(x^2 - 8x + 16) - x^2(x - 5) \leftarrow \text{Collecting like terms and writing the } (x + 4) \text{ multiplied by the expanded and simplified } (x - 4)^2. \text{ Putting this back into the original expression}$$

$$x^3 - 8x^2 + 16x + 4x^2 - 32x + 64 - x^3 + 5x^2 \leftarrow \text{Expanding all the brackets}$$

$$x^2 - 16x + 64 \leftarrow \text{Collecting like terms}$$

Two numbers which multiply to the 64 and add to the -16 are -8 and -8. Putting these in brackets with x factorises it to $(x - 8)(x - 8)$, which can be written as $(x - 8)^2$

(a) $(x - 8)^2$ [6]

- (b) Use your answer to part (a) to write down the value of x which gives the smallest value of this expression.

The smallest value of a squared bracket is 0 and this happens when the brackets is equal to 0. If $x - 8 = 0$, $x = 8$

(b) $x =$ 8 [1]

END OF QUESTION PAPER

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