

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname

Forename(s)

Candidate signature

I declare this is my own work.

GCSE MATHEMATICS

H

Higher Tier

Paper 3 Calculator

Monday 8 June 2020

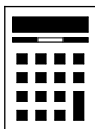
Morning

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a calculator
- mathematical instruments.



Instructions

- Use black ink or black ball-point pen. Draw diagrams in pencil.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- You must answer the questions in the spaces provided. Do not write outside the box around each page or on blank pages.
- If you need extra space for your answer(s), use the lined pages at the end of this book. Write the question number against your answer(s).
- Do all rough work in this book. Cross through any work you do not want to be marked.

Information

- The marks for questions are shown in brackets.
- The maximum mark for this paper is 80.
- You may ask for more answer paper, graph paper and tracing paper. These must be tagged securely to this answer book.

For Examiner's Use

Pages	Mark
2–3	
4–5	
6–7	
8–9	
10–11	
12–13	
14–15	
16–17	
18–19	
20–21	
22–23	
24–25	
26–27	
TOTAL	

Advice

In all calculations, show clearly how you work out your answer.



J U N 2 0 8 3 0 0 3 H 0 1

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

Any writing in blue indicates what must 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

Answer **all** questions in the spaces provided.1 What does $A \cup B$ represent in $P(A \cup B)$?

Circle your answer.

[1 mark]

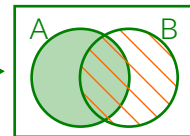
A or B or both

A but not B

not A and not B

A and B

Everything in A is highlighted in green.
Everything in B is lined in orange. The union of
A and B is anything which is highlighted or lined

2 Circle the equation of the line that is parallel to $y = \frac{1}{2}x + 3$

[1 mark]

$y = -2x$

$y = 2x$

$y = \frac{1}{2}x$

$y = -\frac{1}{2}x$

All of the equations are in the form $y = mx + c$, where m is the gradient and c is the y intercept. The gradient needs to be the same if they are parallel

3 Work out 320 as a percentage of 80

Circle your answer.

[1 mark]

25%

75%

300%

400%

$320/80$ expresses 320 as a fraction of 80. Multiplying by 100
converts the fraction into a percentage. $320/80 \times 100 = 400$



- 4 A fair coin is spun four times.
Circle the probability of getting four Heads.

[1 mark]

$\frac{1}{2}$

2

$\frac{1}{8}$

$\frac{1}{16}$

Heads AND heads AND heads AND heads. AND means to multiply the probabilities. The probability of heads is $\frac{1}{2}$. $\frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{16}$

- 5 To the nearest 1000, there are 18 000 people at a festival.

- 5 (a) Write down the minimum possible number of people at the festival.

[1 mark]

Answer 17500

The resolution is 1000 as this is what it is to the nearest. Halving this and subtracting it from the 18000 gives the lower bound, which is the minimum possible number of people. $18000 - 1000/2 = 17500$

- 5 (b) Write down the maximum possible number of people at the festival.

[1 mark]

Answer 18499

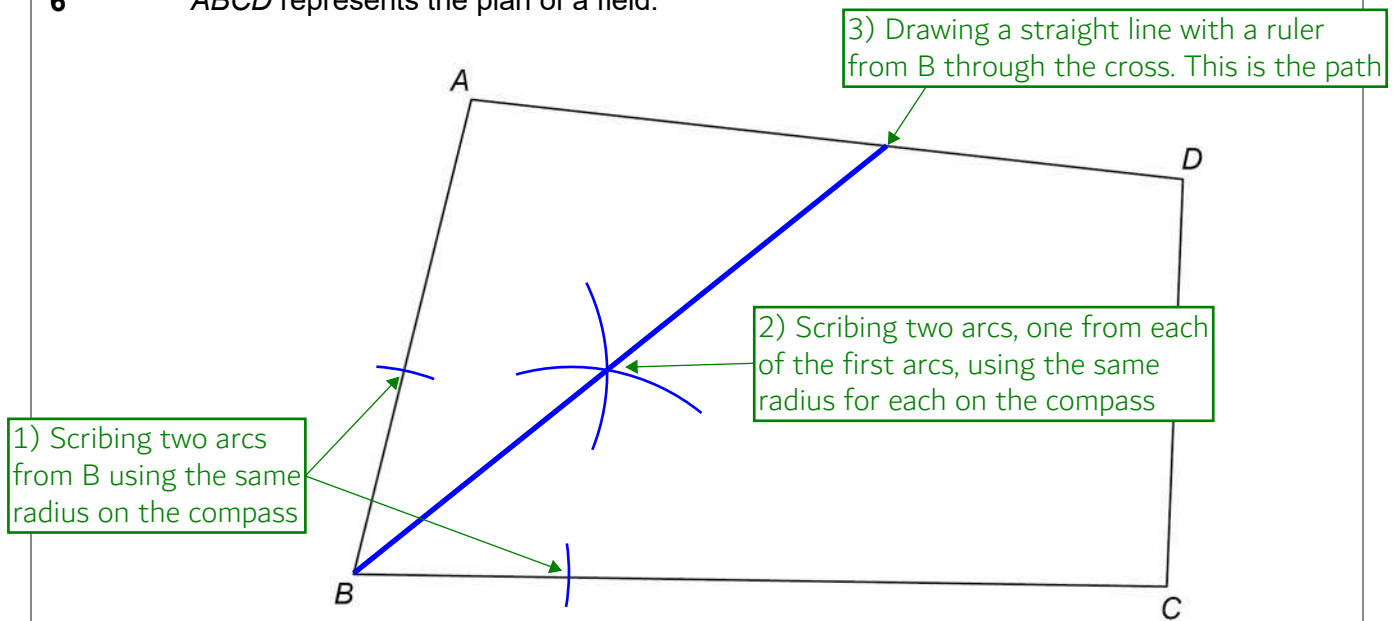
The resolution is 1000 as this is what it is to the nearest. Halving this and adding it from the 18000 gives the upper bound. $18000 + 1000/2 = 18500$. However this rounds up to 19000 so it needs to be 1 fewer than this

Turn over for the next question

Turn over ►



6

 $ABCD$ represents the plan of a field.

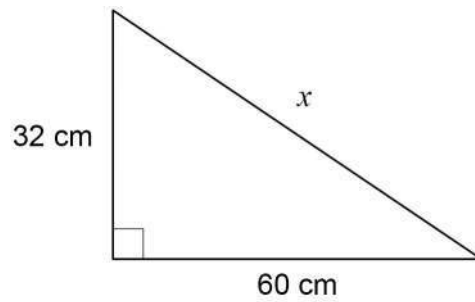
There is a path across the field that
 starts at B
 is the same distance from BA and BC .

Using ruler and compasses, show the position of the path.

[2 marks]



- 7 Use Pythagoras' theorem to work out the value of x .



Not drawn
accurately

[3 marks]

$$32^2 + 60^2 = x^2$$

Pythagoras' Theorem is $a^2 + b^2 = c^2$, where a and b are the shorter sides and c is the longest side. Substituting 32 cm for a , 60 cm for b and x for c

$$x = \sqrt{4624}$$

Square rooting both sides gets rid of the power of 2 and gets x on its own

Answer 68 cm

Turn over for the next question

Turn over ►



8

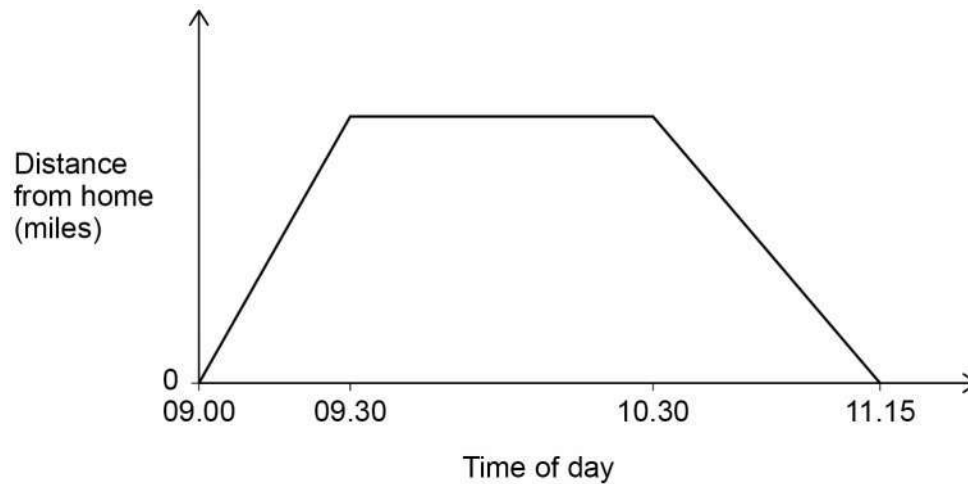
Chris visits a library.

He cycles to the library in half an hour at a speed of 12 miles per hour.

He stays at the library for one hour.

He then cycles home.

The sketch graph represents his visit.



Work out the speed, in miles per hour, at which Chris cycles home.

[3 marks] s^d_t

Writing the speed, distance, time formula triangle

$$12 \times 0.5 = 6$$

Covering d in the formula triangle finds that distance = speed $\times$ time. The speed is 12 mph and the time from 09.00 to 09.30 is 30 minutes, which is put into the calculator as a sexagesimal. So the distance to the library is 6 miles

$$11.15 - 10.30$$

Subtracting 10.30 from 11.15 as sexagesimals works out that it took 45 minutes to cycle home

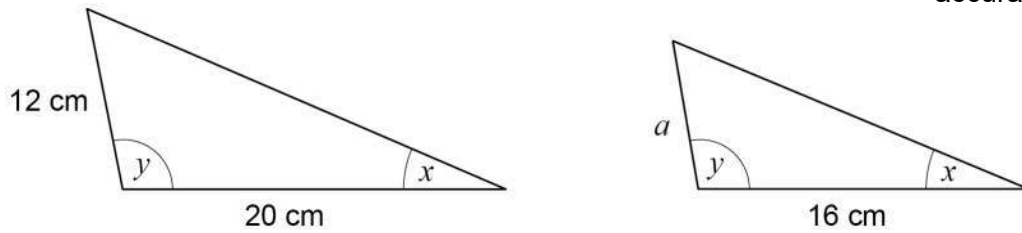
$$6 \div 0.75$$

Covering s in the formula triangle finds that speed = distance $\div$ time. Putting the 45 minutes as a sexagesimalAnswer 8 mph

9

These two triangles are similar.

So all the sides on the smaller triangle are multiplied by the same amount to get the sides on the larger triangle

Not drawn
accuratelyWork out the value of a .

[2 marks]

$$20 \div 16$$

The 20 cm in the larger triangle is the larger version of the 16 cm in the smaller triangle. Dividing these works out that the scale factor (what all the sides in the smaller triangle are multiplied by to get the sides in the larger triangle) is 1.25

$$12 \div 1.25$$

Dividing the 12 cm (which is the larger version of a) by the scale factor works out that a is 9.6 cmAnswer 9.6 cm

10

Expand and simplify fully

$$4(2c + 3) - (5c - 1)$$

[2 marks]

$$8c + 12 - 5c + 1$$

$$\begin{array}{l} 4 \times 2c = 8c \\ 4 \times 3 = 12 \\ -1 \times 5c = -5c \\ -1 \times -1 = 1 \end{array}$$

Answer 3c + 13

$$\begin{array}{l} \text{Collecting like terms:} \\ 8c - 5c = 3c \\ 12 + 1 = 13 \end{array}$$



11 A spinner can land on red, blue or green.

After 350 spins

relative frequency of red = 0.18

relative frequency of blue = 0.62

Work out the number of times the spinner landed on green.

[3 marks]

$$1 - 0.18 - 0.62$$

It is either red, blue or green so the relative frequency of all three must be 1 in total. Subtracting the relative frequency for red and blue from 1 works out that the relative frequency for green is 0.2

$$0.2 \times 350$$

Multiplying the relative frequency of green by the number of spins gives the number of times it landed on green

Answer _____ 70



- 12 Here is some information about 26 houses.
 a , b and c are all **different** numbers.

Number of bedrooms	Number of houses
1	7
2	a
3	b
4	c
5	8

The median number of bedrooms is 3.5

Work out a possible set of values for a , b and c .

[3 marks]

13 houses must have more than 3.5 bedrooms and 13 houses must have less than 3.5 bedrooms as the median is halfway through the data

13-8 ← Subtracting the 8 houses with 5 bedrooms from the 13 houses which have more than 3.5 bedrooms works out that c must be 5

13-7 ← Subtracting the 7 houses with 1 bedroom from the 13 houses which have less than 3.5 bedrooms works out that a and b must add up to 6

$$a = \underline{\hspace{2cm} 2 \hspace{2cm}}$$

$$b = \underline{\hspace{2cm} 4 \hspace{2cm}}$$

$$c = \underline{\hspace{2cm} 5 \hspace{2cm}}$$

2 and 4 are possible numbers for a and b which add up to 6. All three numbers are different



13 (a) Simplify $\frac{25a}{8} \times \frac{2a}{5}$

Give your answer as a single fraction in its simplest form.

[2 marks]

$$\frac{50a^2}{40}$$

← To multiply fractions: multiply the numerators and multiply the denominators

Answer $\frac{5a^2}{4}$

↑
Typing 50/40 into the calculator simplifies it as 5/4. The a^2 stays the same

13 (b) Sofia is trying to simplify $\frac{6c + 10}{2}$

Her method is

divide $6c$ by 2

then

add 10

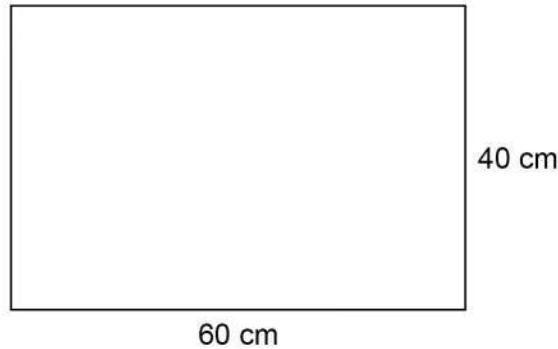
Evaluate her method.

[1 mark]

Should divide 10 by 2 ← Both the $6c$ and the 10 are over 2 so they are both divided by 2



- 14 A rectangle has length 60 cm and width 40 cm



Not drawn
accurately

The length decreases by 15%

The width decreases by 10%

Sue says,

“The perimeter decreases by 25% because 15% + 10% is 25%”

Is she correct?

You **must** show calculations to support your answer.

[4 marks]

$$60 \times \frac{100-15}{100} = 51$$

Subtracting the 15% from 100% expresses the percentage the length goes down to. Putting this over 100 converts it to a fraction, which reduces the length by 15% when multiplied. So the new length is 51 cm

$$40 \times \frac{100-10}{100}$$

Subtracting the 10% from 100% expresses the percentage the width goes down to. Putting this over 100 converts it to a fraction, which reduces the width by 10% when multiplied. So the new width is 36 cm

$$51 \times 2 + 36 \times 2 = 174$$

Working out that the new perimeter is 174 cm by adding 2 lots of the new length and 2 lots of the new width

$$60 \times 2 + 40 \times 2$$

Working out that the original perimeter was 200 cm by adding 2 lots of the original length and 2 lots of the original width

$$200 \times \frac{100-25}{100} = 150$$

Subtracting the 25% from 100% expresses the percentage the original perimeter is meant to go down to. Putting this over 100 converts it to a fraction, which reduces the original perimeter by 25% when multiplied. So the original perimeter reduced by 25% is 150 cm

No

Reducing the original perimeter by 25% gives 150 cm, which is not the same as the new perimeter when the length and width is reduced



15 Solve $4 > 11 - \frac{x}{3}$

$\frac{x}{3} + 4 > 11$ ← Adding $x/3$ to both sides to eliminate the negative x term

$\frac{x}{3} > 7$ ← Subtracting 4 from both sides to get the x term on its own

[2 marks]

Answer $x > 21$

Multiplying both sides by 3 to eliminate the denominator and get x on its own

16 The number of goals scored by 20 players in a season is shown.

Number of goals	Frequency	Midpoint	
0 to 4	6	2	12
5 to 9	11	7	77
10 to 14	3	12	36
Total = 20			

$125 \div 20$ ← D

C

Work out an estimate of the mean number of goals per player.

Give your answer as a decimal.

[3 marks]

A: Working out the midpoints by doing the mean of the lowest and highest values in each category. For 0 to 4, $0 + 4 = 4$ then $4 \div 2 = 2$. For 5 to 9, $5 + 9 = 14$ then $14 \div 2 = 7$. For 10 to 14, $10 + 14 = 24$ then $24 \div 2 = 12$.

B: Multiplying the midpoints by the frequency to get an estimated total for each category. $6 \times 2 = 12$, $11 \times 7 = 77$ and $3 \times 12 = 36$.

C: Adding all of the estimated totals to get an overall estimated total. $12 + 77 + 36 = 125$.

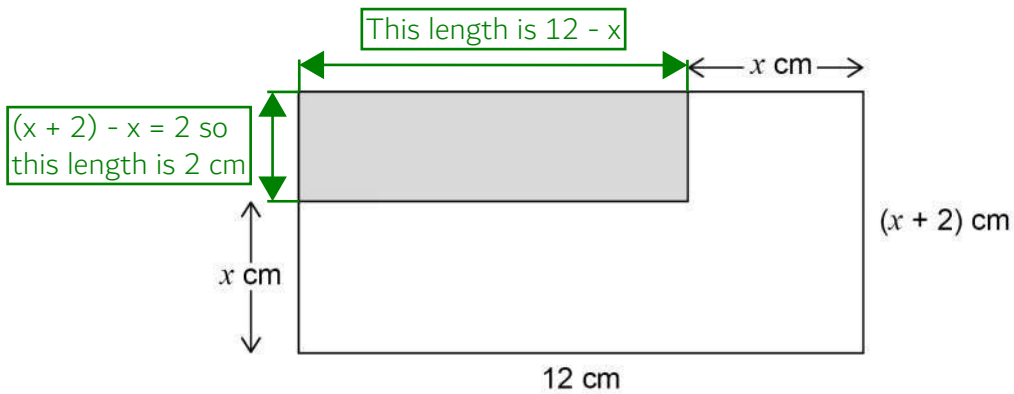
D: Mean = total $\div$ number so dividing the overall estimated total by the 20 players

Answer 6.25



17

Here are two rectangles.

Not drawn
accurately

The area of the shaded rectangle is $\frac{1}{4}$ the area of the large rectangle.

Work out the value of x .

[4 marks]

This expresses $\frac{1}{4}$ of the area of the large rectangle. Area of rectangle = length $\times$ width

$$2(12 - x) = \frac{1}{4} \times 12(x + 2)$$

Writing the area of the shaded rectangle is $\frac{1}{4}$ the area of the large rectangle as an equation

This expresses the area of the shaded rectangle. Area of rectangle = length $\times$ width

$$24 - 2x = 3x + 6$$

$\frac{1}{4} \times 12 = 3$. Expanding the brackets

$$24 = 5x + 6$$

Adding $2x$ to both sides to get all the x on the same side

$$18 = 5x$$

Subtracting 6 from both sides to get the x term on its own

Answer 3.6

Dividing both sides by 5 gets x on its own



18 The pressure in a tyre is 30 pounds per square inch.

Convert the pressure into kilograms per square centimetre.

Use 1 pound = 0.45 kilograms
and
1 inch = 2.54 centimetres

[3 marks]

$$30 \times 0.45$$

← Multiplying 30 pounds by 0.45 converts it into 13.5 kilograms

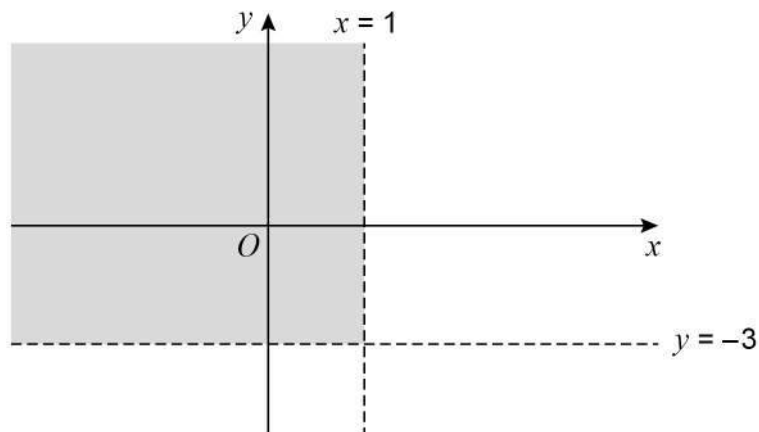
$$13.5 \div 2.54^2$$

← Kilograms per square centimetre means to divide the kilograms by the square centimetres. 1 square inch is 2.54^2 square centimetres

Answer 2.1 kg/cm²



- 19 The sketch shows the lines $x = 1$ and $y = -3$



Which pair of inequalities describes the shaded region?

Tick **one** box.

[1 mark]

☐

$x < 1$ and $y < -3$

☒

$x < 1$ and $y > -3$

☐

$x > 1$ and $y > -3$

☐

$x > 1$ and $y < -3$

The region is on the left of the line $x = 1$ so x must be less than 1.
The region is above the line $y = -3$ so y must be greater than -3

Turn over for the next question

Turn over ►



20 Amari and Ben each play a game.

20 (a) Here is some information about Amari's scores.

Lowest 12

Highest 20

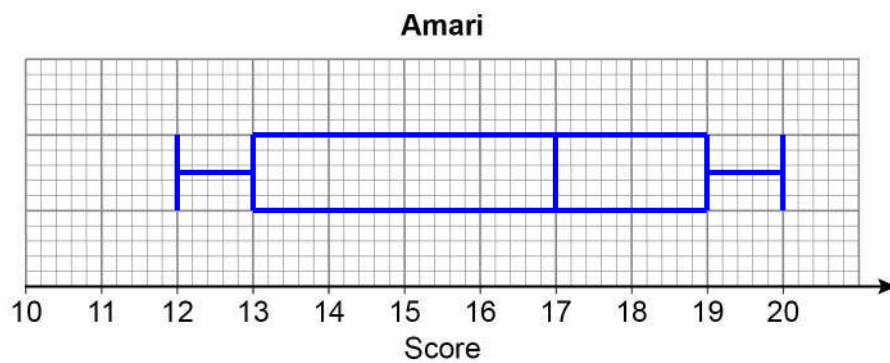
Lower quartile 13

Upper quartile 19

Median 17

Draw a box plot to represent his scores.

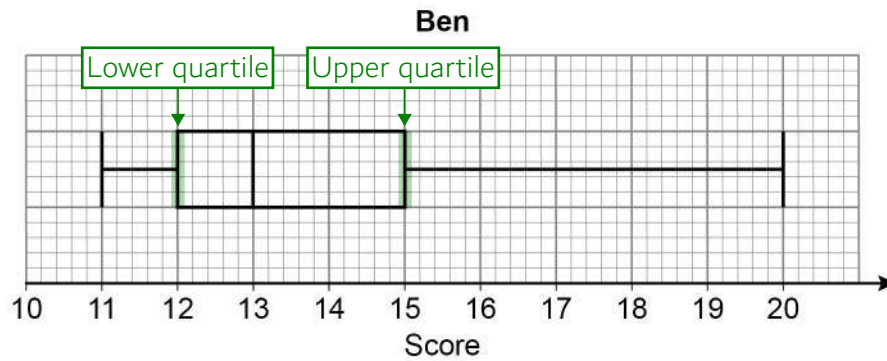
[2 marks]



Vertical lines drawn for the lowest, highest, lower quartile, upper quartile and median. Joining the lowest and lower quartile with a horizontal line and the upper quartile and highest with a horizontal line. Drawing a box around the quartiles



20 (b) This box plot represents Ben's scores.



Who had more consistent scores, Amari or Ben?

Work out the interquartile ranges to support your answer.

[2 marks]

$19 - 13 = 6$ ← Interquartile range = upper quartile - lower quartile. So Amari's interquartile range is 6

$15 - 12 = 3$ ← Interquartile range = upper quartile - lower quartile. So Ben's interquartile range is 3

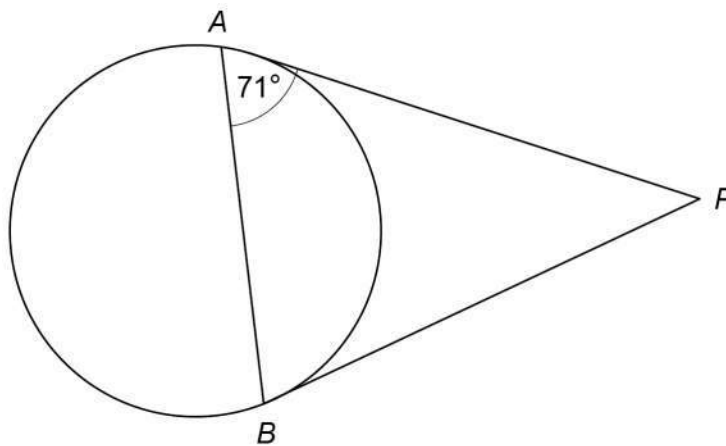
Ben ← Ben's interquartile range was lower so he was more consistent

Turn over for the next question

Turn over ►



- 21 (a) A and B are points on a circle.
 PA and PB are tangents.



Not drawn
accurately

Work out the size of angle APB .

[2 marks]

$$180 - 71 - 71$$

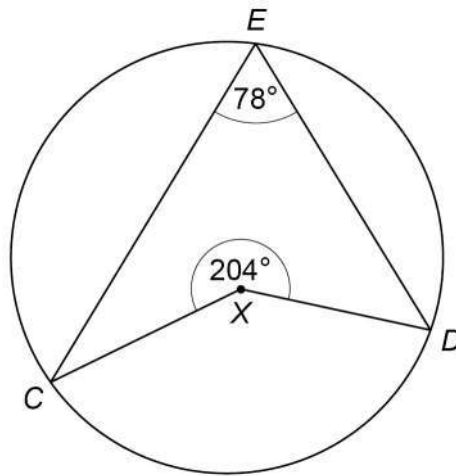
Triangle ABP is isosceles as sides PA and PB are equal as tangents from the same point are equal in length. Angle ABP is 71 degrees as the base angles of an isosceles triangle are equal. There are 180 degrees in total in a triangle so subtracting angles BAP and ABP from 180 degrees leaves angle APB

Answer 38 degrees



21 (b) C, D and E are points on a different circle.

Not drawn
accurately



Is X the centre of the circle?

Tick a box.



Yes



No

Show working to support your answer.

[2 marks]

$$360 - 204$$

There are 360 degrees in total around a point. So subtracting the 204 degrees from 360 degrees works out that the minor angle CXD is 156 degrees

$$156 \div 2 = 78$$

The angle at the circumference is half the angle at the centre. Halving the minor angle CXD gives 78 degrees, which is the same as the angle at the circumference. As the circle theorem holds, X must be the centre of the circle

Turn over for the next question



22

Visitors to a museum buy a child ticket or an adult ticket.

Here is some information about two groups of visitors.

Group X	250 visitors, including 120 children
Group Y	number of children : number of adults = 17 : 15

One visitor from each group is picked at random.

Is this statement correct?

Probability of picking two children > probability of picking two adults

You **must** show your working.

[4 marks]

$$\frac{120}{250} \times \frac{17}{17+15} = 0.255$$

The probability of picking two children. Child AND child. AND means to multiply the probabilities. The probability of picking a child from Group X is 120/250. The probability of picking a child from Group Y is 17 out the total number of parts in the ratio

$$\frac{250-120}{250} \times \frac{15}{17+15} = 0.24$$

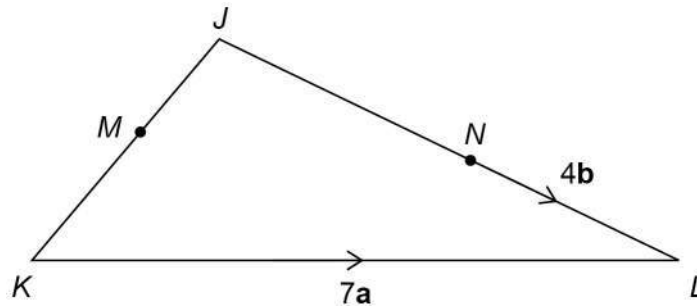
The probability of picking two adults. Adult AND adult. AND means to multiply the probabilities. The probability of picking an adult from Group X is (250 - 120)/250 as 250 - 120 works out how many adults there are. The probability of picking an adult from Group Y is 15 out the total number of parts in the ratio. The whole decimal isn't written down as we see that it is less than 0.255 just by quoting it to 2 decimal places

Yes

The probability of picking two children is greater than the probability of picking two adults



23

In triangle JKL M is the midpoint of JK $JN : NL = 3 : 2$ $\vec{KL} = 7\mathbf{a}$ $\vec{NL} = 4\mathbf{b}$ Not drawn
accuratelyWork out $\vec{JM}$ in terms of $\mathbf{a}$ and $\mathbf{b}$.

Give your answer in its simplest form.

[3 marks]

$4b \div 2$

2 parts of the ratio represent NL. So dividing $\vec{NL}$ by 2 works out that 1 part of the ratio is worth $2\mathbf{b}$

$2b \times 5$

$3 + 2 = 5$ so there are 5 parts in total in the ratio which represent $\vec{JL}$. So multiplying the value of 1 part of the ratio by 5 works out that $\vec{JL} = 10\mathbf{b}$

$10b - 7a$

This expresses $\vec{JK}$. $\vec{JK} = \vec{JL} + \vec{LK}$. $\vec{LK} = -\vec{KL}$

Answer

$5b - 3.5a$

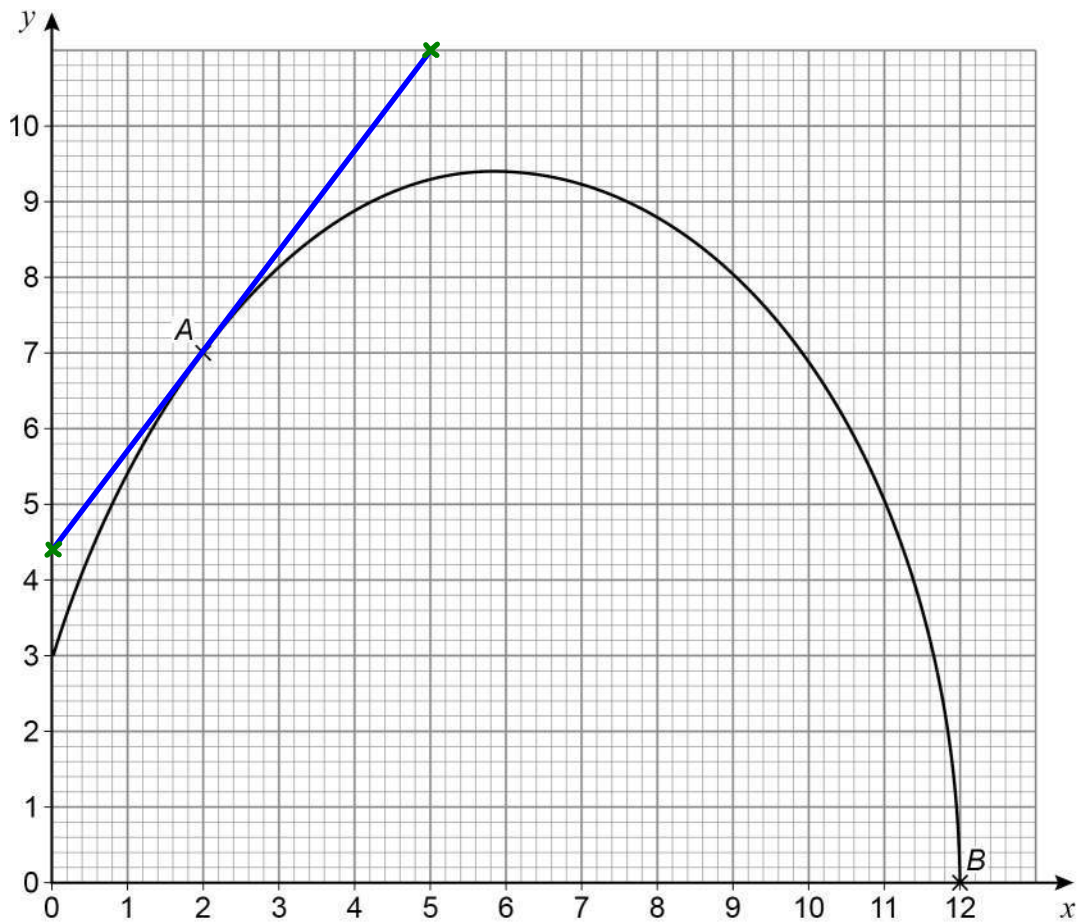
$\vec{JM}$ is half of $\vec{JK}$ as M is the midpoint of JK

Turn over for the next question

Turn over ►



- 24 A and B are points on a curve.
 A is $(2, 7)$ B is $(12, 0)$



- 24 (a) Work out the instantaneous rate of change of y with respect to x at point A .

[2 marks]

$$\frac{11 - 4.4}{5 - 0}$$

Instantaneous rate of change is the gradient. Drawing a tangent at point A .
 Gradient = (change in y)/(change in x). Picking two points which are on grid lines and as far away from each other as possible to get the most accurate gradient

Answer 1.32



24 (b) The average rate of change of y with respect to x between points A and B is worked out.

Which statement is correct?

Tick **one** box.

[1 mark]

☐

It is positive.

☐

It is zero.

☒

It is negative.

☐

You cannot tell if it is positive or negative.

The straight line from A to B has a negative gradient

25 The equation of a circle is $x^2 + y^2 = 9$

Work out the length of the **diameter**.

Circle your answer.

[1 mark]

3

6

9

18

The general equation of a circle with its centre at the origin is $x^2 + y^2 = r^2$, where r is the radius. $r^2 = 9$ and square rooting both sides of this gives $r = 3$. The diameter is double the radius and $3 \times 2 = 6$

Turn over for the next question



26 Prove algebraically that $3.4\dot{7} = \frac{313}{90}$

[3 marks]

$$x = 3.4\dot{7} \leftarrow \text{Let } x \text{ be the recurring decimal}$$

$$10x = 34.\dot{7} \leftarrow \text{There is one recurring digit so multiplying by ten once allows the recurring digit to be written in the same decimal place}$$

$$9x = 31.3 \leftarrow \text{Subtracting the } x \text{ from } 10x \text{ leaves } 9x \text{ and cancels out the recurring digit}$$

$$x = \frac{31.3}{9} = \frac{313}{90} \leftarrow \text{Dividing both sides by 9 expresses } x \text{ as a fraction which simplifies to } 313/90$$

27 The equation of a curve is $y = (x - 1)^2 - 6$

Circle the coordinates of the turning point.

[1 mark]

$(-1, -6)$

$(1, 6)$

$(-1, 6)$

$(1, -6)$

The equation is in completed the square form. The turning point occurs when the square bracket is equal to 0. When $x - 1 = 0$, $x = 1$. $y = 0^2 - 6 = -6$



28 Line A has equation $y = 4x - 1$

Line B is

perpendicular to line A

and

passes through the point (8, 5)

Work out the coordinates of the point where line B intersects the x -axis.

[4 marks]

$$5 = -\frac{1}{4} \times 8 + c$$

The general equation of a straight line is $y = mx + c$, where m is the gradient and c is the y -intercept. Substituting in the point (8, 5) so 8 for x and 5 for y . Substituting $-1/4$ for m as the gradient of line B must be the negative reciprocal to the gradient of line A (as it is perpendicular) and the gradient of line A is 4

$$c = 7$$

Rearranging to find c by adding $1/4 \times 8$ to both sides to get c on its own

$$0 = -\frac{1}{4}x + 7$$

Substituting 0 for y , $-1/4$ for m and 7 for c into the general equation $y = mx + c$. y must be 0 as it is intersecting the x -axis

$$-7 = -\frac{1}{4}x$$

Subtracting 7 from both sides to get the x term on its own

Answer (28 , 0)

Dividing both sides by $-1/4$ finds that $x = 28$. $y = 0$ as it is intersecting the x -axis

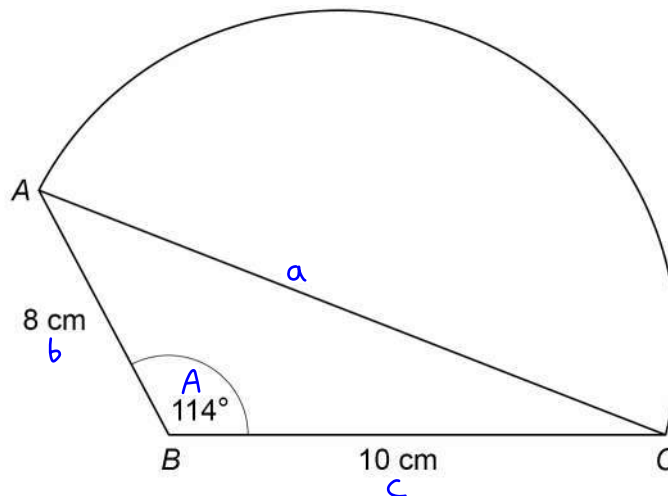
Turn over for the next question



29

A shape is made by joining triangle ABC to a semicircle with diameter AC .

Not drawn
accurately



Work out the **total** area of the shape.

[5 marks]

$$\frac{1}{2} \times 8 \times 10 \times \sin 114 = 36.5...$$

This works out that the area of the triangle is 36.5... cm².
Area of triangle = $\frac{1}{2} ab \sin C$, where a and b are sides and C is the angle between them. Substituting 8 for a, 10 for b and 114 for C

$$AC^2 = 8^2 + 10^2 - 2 \times 8 \times 10 \times \cos 114$$

There are not two pairs of opposite sides and angles in the triangle so the sine rule cannot be used. So using the cosine rule. $a^2 = b^2 + c^2 - 2bc \cos A$. Substituting in the values as labelled on the diagram

$$AC = \sqrt{229.0...}$$

Square rooting both sides finds that $AC = 15.1...$ cm

$$15.1... \div 2$$

Halving AC works out that the radius of the semicircle is 7.5... cm

$$\frac{\pi \times 7.5...^2}{2}$$

Area of circle = $\pi \times \text{radius}^2$. Halving the area of the circle works out that the area of the semicircle is 89.9... cm²

$$89.9... + 36.5...$$

Adding the area of the triangle to the area of the semicircle works out the total area of the shape

Answer 126.5 cm²



30

$$f(x) = \frac{1}{2}x$$

$$g(x) = x - x^2$$

Solve $f^{-1}(x) = gf(x)$ **[4 marks]**

$$x = \frac{1}{2}y$$

The inverse function $f^{-1}(x)$ is found by switching $f(x)$ with x and x with y then rearranging to make y the subject

$$y = 2x$$

Multiplying both sides by 2 eliminates the $1/2$ and gets y on its own. So $f^{-1}(x) = 2x$

$$\frac{1}{2}x - \left(\frac{1}{2}x\right)^2$$

The composite function $gf(x)$ means to put $f(x)$ into $g(x)$. $1/2 x$ is substituted for all x in $g(x)$

$$2x = \frac{1}{2}x - \frac{1}{4}x^2$$

Setting $f^{-1}(x)$ equal to the simplified $gf(x)$

$$\frac{1}{4}x^2 + \frac{3}{2}x = 0$$

Adding $1/4 x^2$ to both sides and subtracting $1/2 x$ from both sides to put it into the quadratic form $ax^2 + bx + c = 0$

$$\frac{-1.5 \pm \sqrt{1.5^2 - 4 \times 0.25 \times 0}}{2 \times 0.25}$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Solving using the quadratic formula.
 $a = 1/4 = 0.25$. $b = 3/2 = 1.5$. $c = 0$

Answer $x=0, x=-6$

END OF QUESTIONS