

Please write clearly in block capitals.

Centre number

Candidate number

Surname _____

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE MATHEMATICS

H

Higher Tier Paper 3 Calculator

Monday 8 June 2020

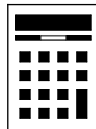
Morning

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.



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 order to answer the questions and get the marks. The worked solutions have been designed to show the smallest amount of work which needs to be done to answer the question.

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

Anything written in orange in a rectangle doesn't have to be written in the exam and is there to show what should be put into a calculator or measured using a ruler or protractor.

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

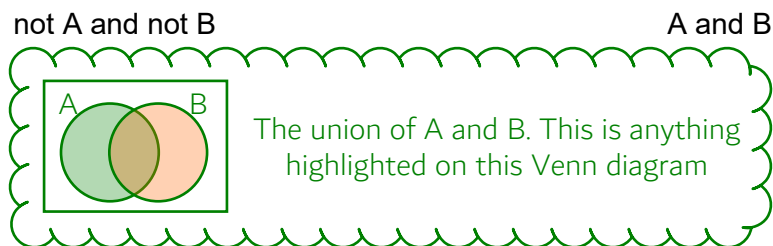
Answer **all** questions in the spaces provided.

- 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



- 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%

$$\frac{320}{80} \times 100$$

$\frac{320}{80}$ expresses 320 as a fraction of 80. Multiplying by 100 converts it into a percentage



- 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. 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

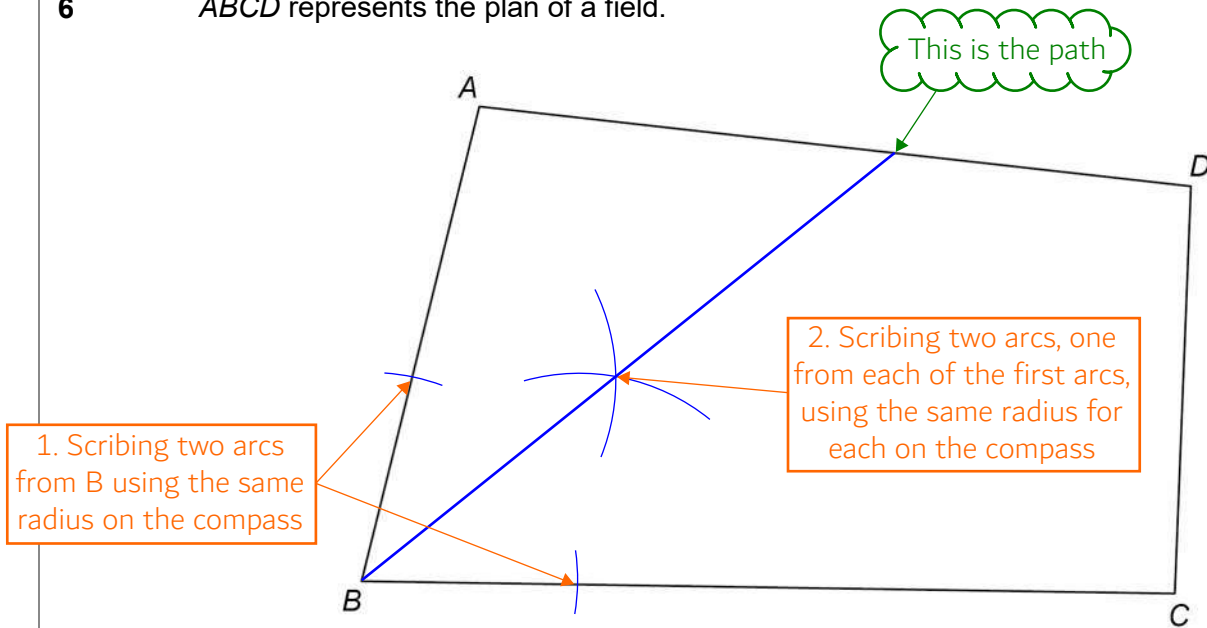
The resolution is 1000. Halving this and adding it from the 18000 gives the upper bound. $18000 + 1000/2 = 18500$. However this rounds up to 19000 so it needs to be 1 fewer than this

Turn over for the next question

Turn over ►



6

 $ABCD$ represents the plan of a field.

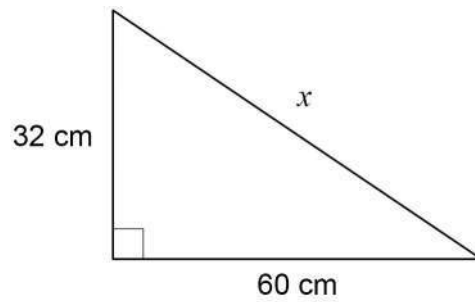
There is a path across the field that
 starts at B
 is the same distance from BA and BC .

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]

$$a^2 + b^2 = c^2$$

Pythagoras' Theorem where a and b are the shorter sides and c is the longest side

$$\sqrt{32^2 + 60^2}$$

Made c the subject by square rooting both sides. Then substituting 32 for a and 60 for b

Answer 68 cm

Turn over for the next question



8

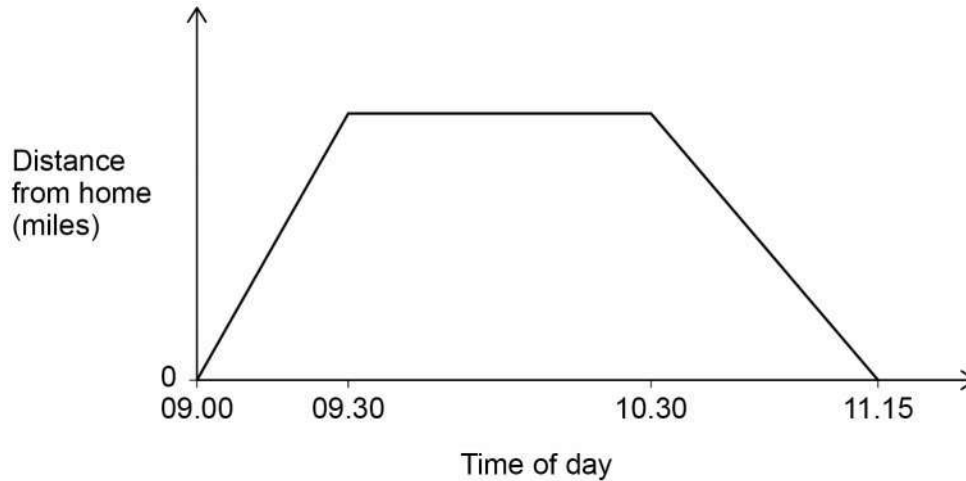
Chris visits a library.

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 formula triangle for speed, distance and time

$$\frac{12 \times (9:30 - 9:00)}{11:15 - 10:30}$$

Speed = distance/time. The distance on the way back is the same as the distance on the way there. Distance = speed x time. The speed on the way there is 12mph. The time on the way there is found by subtracting 9:00 from 9:30 as this works out the difference in time. The time on the way back is found by subtracting 10:30 from 11:15

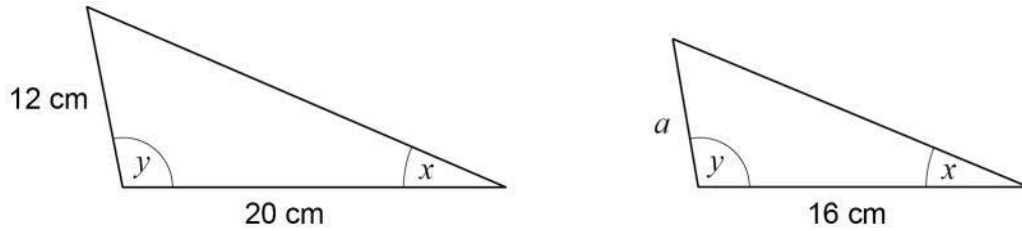
Answer 8 mph**FACT B**

To enter time in the calculator: enter the hours, press the button on the left, enter the minutes, press the button on the left. 9:30 will appear as 9°30°



9

These two triangles are similar.

Not drawn
accuratelyWork out the value of a .

[2 marks]

$$\frac{16}{20} \times 12$$

16/20 is the fraction the smaller triangle is of the larger triangle. Working out this fraction of the 12

Answer 9.6 cm

10

Expand and simplify fully

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

[2 marks]

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

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

Answer 3c + 13

Collecting like terms:

$$\begin{aligned} 8c - 5c &= 3c \\ 12 + 1 &= 13 \end{aligned}$$

Turn over ►



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]

$$(1 - 0.18 - 0.62) \times 350$$

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

It is either red, blue or green so the relative frequency of all three must be 1 as it was always one of them. Subtracting the relative frequency for red and blue leaves the relative frequency for 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]

$$\frac{26+1}{2} = 13.5$$

Using the formula $(n + 1)/2$, where n is the number of houses, tells us that the median is halfway between the 13th value, which must be 3, and 14th value, which must be 4, in order for the median to be 3.5

$$c = 13 - 8$$

$$a + b = 13 - 7$$

13 houses are after the median and 13 houses are before. Therefore subtracting the 8 5 bedroom houses from the 13 must leave c and subtracting the 7 1 bedroom houses from the 13 must leave a and b

$$a = \underline{\quad\quad\quad 2 \quad\quad\quad}$$

$$b = \underline{\quad\quad\quad 4 \quad\quad\quad}$$

$$c = \underline{\quad\quad\quad 5 \quad\quad\quad}$$

c must be 5. a and b must not be 5, must add to 6 and b can't be 0 as the 13th value needs to be 3 bedrooms



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

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

[2 marks]

To multiply fractions, the numerators and denominators can be multiplied. This can be written as $(25 \times 2 \times a \times a)/(8 \times 5)$. $a \times a = a^2$

$$(25 \times 2)/(8 \times 5) = 5/4$$

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

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

Her method is

divide $6c$ by 2

then

add 10

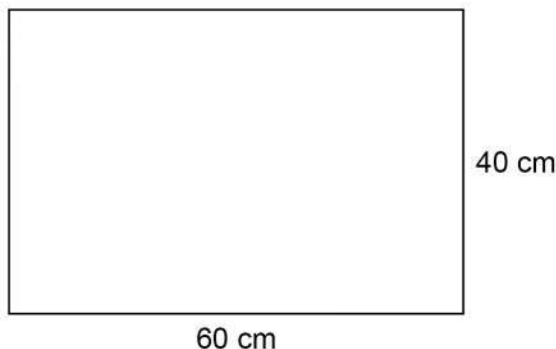
Evaluate her method.

[1 mark]

Should divide 10 by 2



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]

$$\frac{100-25}{100} \times (2 \times 60 + 2 \times 40) = 150$$

The original perimeter decreased by 25%

Percentage is out of 100. Subtracting 25 works out what percentage the perimeter goes down to when it is reduced by 25%. Dividing the result by 100 converts it into a multiplier which reduces anything by 25% when multiplied by it

The original perimeter. Perimeter is all of the outside sides added together. Adding two lots of the 60cm and two lots of the 40cm together

$$2 \times \frac{100-15}{100} \times 60 + 2 \times \frac{100-10}{100} \times 40 = 174$$

Adding two lots of the 60cm reduced by 15% and two lots of the 40cm reduced by 10% to get the new perimeter. The percentage decreases are converted into multipliers in a similar way to above

NO

The perimeter did not decrease by 25% as the new perimeter is 174cm, not 150cm



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

[2 marks]

$$(4 - 11)x - 3 < x$$

Subtracting 11 from both sides then multiplying both sides by -3.
The inequality symbol needs to flip when multiplying by a negative

Answer $x > 21$

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

Number of goals	Frequency	Midpoint	
0 to 4	6		
5 to 9	11		
10 to 14	3		
Total = 20			

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

Give your answer as a decimal.

[3 marks]

$$\frac{6 \times \frac{0+4}{2} + 11 \times \frac{5+9}{2} + 3 \times \frac{10+14}{2}}{20}$$

Mean = total/number, where total is the total number of goals for all of the players and number is the number of players. The total number of goals is estimated by multiplying the midpoint of each category by its frequency. The midpoints are worked out by doing the mean of the highest number and lowest number of each category. The number of players is 20

Answer 6.25

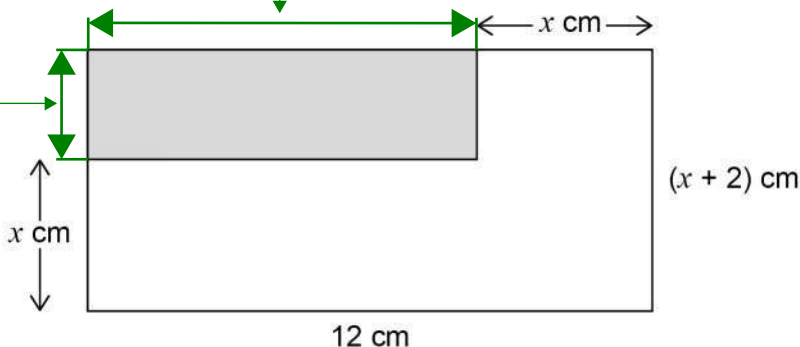


17 Here are two rectangles.

This length is $12 - x$

Not drawn accurately

$(x + 2) - x = 2$ so this length is 2cm



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

Work out the value of x .

[4 marks]

Area of rectangle = length \times width

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

Setting the area of the shaded rectangle equal to $\frac{1}{4}$ of the area of the large rectangle

Area of the shaded rectangle. Its length is $(12 - x)$ and its width is 2

Area of the large rectangle. Its length is 12 and its width is $(x + 2)$

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

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

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

Adding $2x$ to both sides to get the x terms on the same side. Then subtracting 6 from both sides to get the x terms on their own

Answer $\frac{18}{5}$

$24 - 6 = 18$. $3x + 2x = 5x$. Dividing both sides by 5 works out x



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]

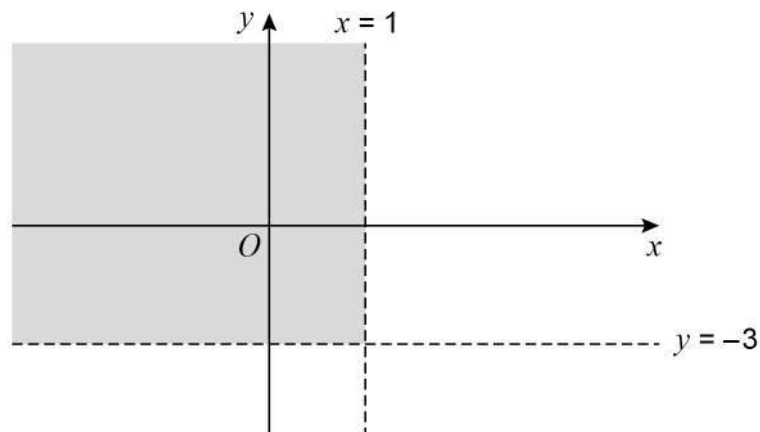
$$\frac{30 \times 0.45}{2.54^2}$$

30 x 0.45 converts the pounds into kilograms. 1 square inch is 2.54² square centimetres so dividing by this otherwise it would be in kilograms per 2.54² square centimetres. Per means to divide

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

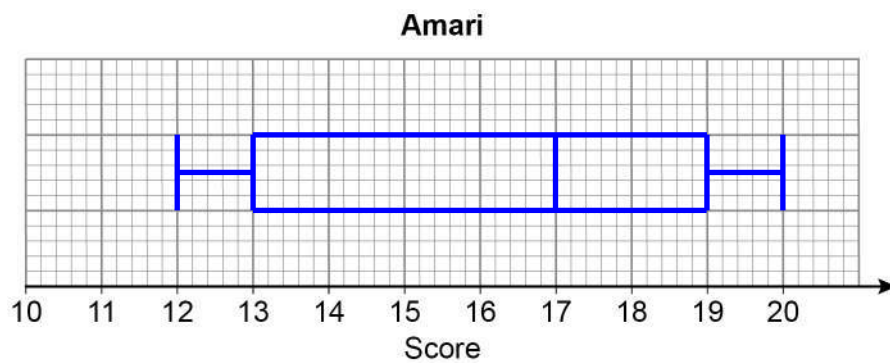
Lower quartile 13

Upper quartile 19

Median 17

Draw a box plot to represent his scores.

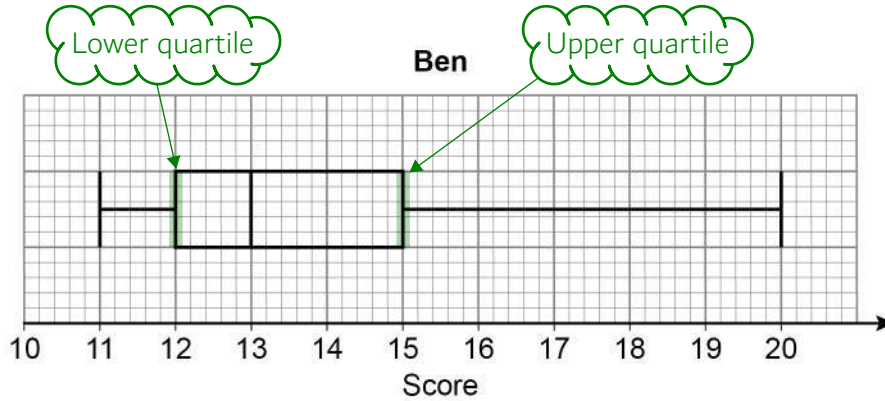
[2 marks]



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]

Interquartile range = upper quartile - lower quartile

$$19 - 13 = 6$$

Amari's interquartile range

$$15 - 12 = 3$$

Ben's interquartile range

Ben

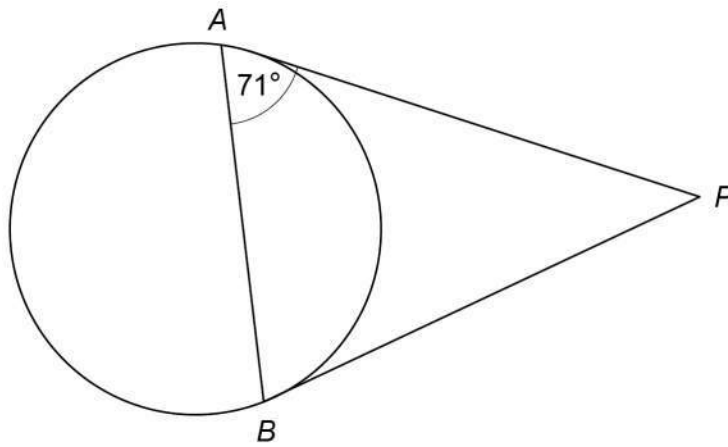
Ben's interquartile range was lower so he was more consistent

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]

$$180 - 71 - 71$$

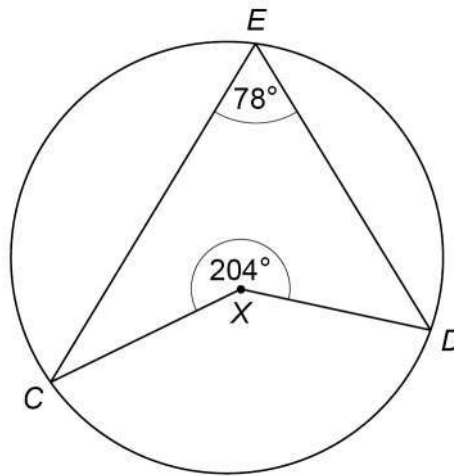
Triangle ABP is isosceles as sides PA and PB are equal as tangents from the same point are equal in length. Angle ABP is 71° as the base angles of an isosceles triangle are equal. There are 180° in total in a triangle and subtracting the other angles leaves angle APB

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]

$$\frac{360 - 204}{2} = 78$$

360 - 204 works out the angle CXD . Assuming that X is the centre of the circle, this will be double the angle at the circumference so dividing by 2 works out what the angle at the circumference would be. This is 78, as it is on the diagram. Therefore the assumption that X is the centre of the circle must be correct

Turn over for the next question

Turn over ►



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

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

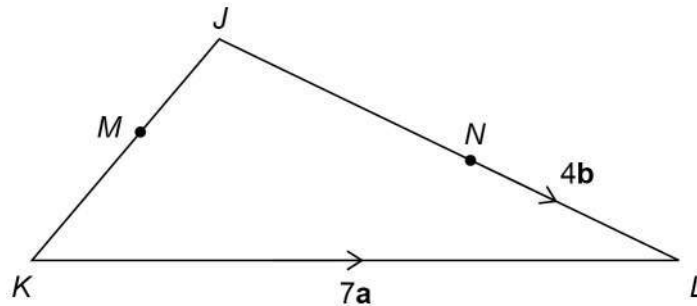
The probability of picking two adults. Adult AND adult. AND means to multiply the probabilities. The probability of picking an adult from Group X is (250 - 120)/250 as 250 - 120 works out how many adults there are. The probability of picking an adult from Group Y is 15 out the total number of parts in 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]

$$\frac{1}{2} \left(\frac{4\mathbf{b}}{2} \times 5 - 7\mathbf{a} \right)$$

$\vec{JM} = \frac{1}{2} \vec{JK}$ as M is the midpoint of JK . $\vec{JK} = \vec{JL} + \vec{LK}$. $\vec{LK} = -7\mathbf{a}$ as it is in the opposite direction to \vec{KL} . \vec{JL} is represented by 5 parts in the ratio $JN : NL$. \vec{NL} is two parts and is $4\mathbf{b}$. Dividing this by 2 works out what 1 part is worth then multiplying by 5 works out the 5 parts

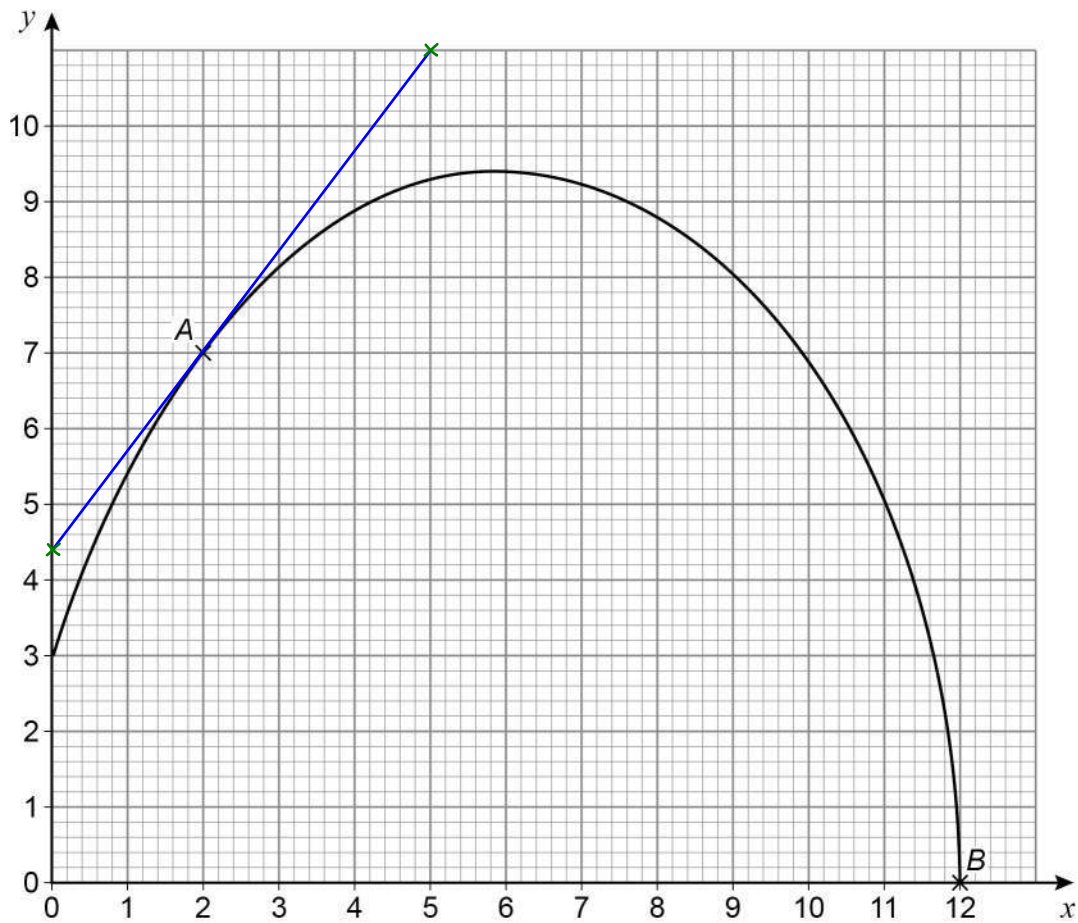
Answer $5\mathbf{b} - \frac{7}{2}\mathbf{a}$

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]

$$x = 3.4\dot{7}$$

$$10x = 34.7\dot{7}$$

$$9x = 31.3$$

$$x = \frac{31.3}{9} = \frac{313}{90}$$

Let x be the recurring decimal. There is one recurring digit so multiplying by ten once allows the recurring digit to be written in the same decimal place. Subtracting the x from $10x$ leaves $9x$ and cancels out the recurring digit. This can be rearranged to express x as a fraction, which can be simplified to give $313/90$

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 $x - 1 = 0$, $x = 1$ and as $0^2 = 0$, $y = -6$



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]**

$$y = mx + c$$

This is the general equation of a straight line, where m is the gradient and c is the y intercept

$$c = 5 - \frac{1}{4} \times 8 = 7$$

Rearranged to make c the subject. $c = y - mx$.
Substituted in the 8 for x and 5 for y as the line B goes through the point (8, 5). Substituted $-1/4$ for m as the gradient of line A is 4 and the gradients of perpendicular lines are the negative reciprocal of each other

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

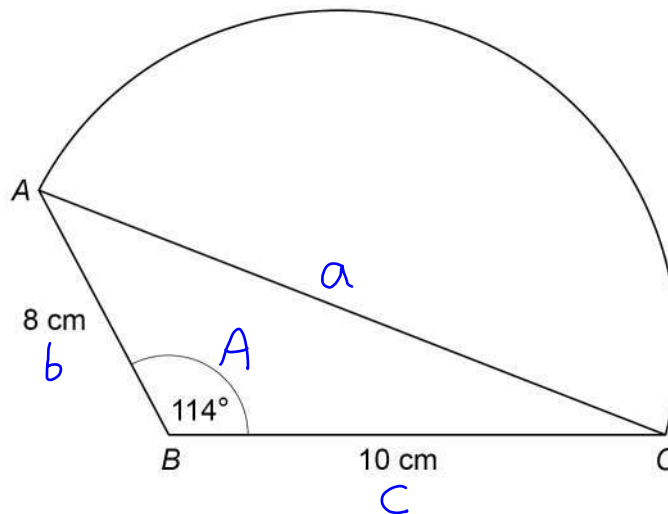
Rearranged to make x the subject. $x = (y - c)/m$.
Substituted in 0 for y as we are finding the x coordinate of the point where the line B intersects the x -axis and y must be 0 for this to happen. Substituted $-1/4$ for m and 7 for c

Answer (28 , 0)

Turn over for the next question



29

A shape is made by joining triangle ABC to a semicircle with diameter AC .Not drawn
accuratelyWork out the **total** area of the shape.**[5 marks]**

$$a^2 = b^2 + c^2 - 2bc \cos A$$

Quoting the cosine rule so that it can be used to work out side AC in triangle ABC

$$\frac{1}{2} \times 8 \times 10 \times \sin 114 + \frac{1}{2} \times \pi \times \left(\frac{\sqrt{8^2 + 10^2 - 2 \times 8 \times 10 \times \cos 114}}{2} \right)^2$$

Adding the area of the triangle to the area of the semicircle gives the total area of the shape

Area of a triangle = $\frac{1}{2} \times a \times b \times \sin C$, where a and b are sides of the triangle and C is the angle between them

Area of semicircle = $\frac{1}{2} \times \pi \times r^2$, where r is the radius. The radius is half of the diameter AC , which is found by rearranging the cosine rule to make a the subject then substituting in 8 for b , 10 for c and 114 for A

Answer 126.5 cm²



30

$$f(x) = \frac{1}{2}x \quad g(x) = x - x^2$$

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

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

$$f^{-1}(x) = 2x$$

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

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

The composite function $gf(x)$ means to put the function f into the function g . $\frac{1}{2}x$ is substituted for all x in $g(x)$

$$\frac{8}{4}x = \frac{2}{4}x - \frac{1}{4}x^2$$

Setting $f^{-1}(x)$ equal to $gf(x)$ and writing it so that all the denominators are the same

$$x^2 + 6x = 0$$

Multiplying both sides by 4 to eliminate the denominators. Then adding x^2 and subtracting $2x$ from both sides

$$x(x+6) = 0$$

Factorising to solve as there are two powers of x

Answer

$$x = 0, x = -6$$

$$\text{Either } x = 0 \text{ or } x + 6 = 0$$

END OF QUESTIONS