AQA

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 1 Non-Calculator

Tuesday 1 November 2022 Morning Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- mathematical instruments
- the Formulae Sheet (enclosed).

You must **not** use a calculator.

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.

Advice

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

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	
TOTAL	

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

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

1 Work out $-4 \times -\frac{7}{9}$

Circle your answer.

[1 mark]

$-\frac{28}{36}$ $-\frac{28}{9}$ $\frac{28}{36}$ [✓ $\frac{28}{9}$]

-4 can be written as -4/1. To multiply fractions, multiply the numerators and multiply the denominators. -4 x -7 = 28, as two negatives multiplied is a double negative so it becomes positive. 1 x 9 = 9

2 Circle the value of $\left(\sqrt{6}\right)^4$

[1 mark]

12 [✓ 36] 10 $\sqrt{24}$

To the power of 4 is squaring then squaring again. The opposite of square rooting is squaring so the square and square root cancel out when $\sqrt{6}$ is squared to give 6. Then $6^2 = 36$

3 $0.203 = \frac{1}{5} + x$

Circle the value of x.

[1 mark]

$\frac{1}{300}$ $\frac{1}{3000}$ $\frac{3}{100}$ [✓ $\frac{3}{1000}$]

$0.203-\frac{1}{5}=x$

Subtracting 1/5 from both sides gets x on its own

$\frac{203}{1000}-\frac{200}{1000}$

Converting 0.203 into a fraction and then 1/5 so that it has the same denominator as 203/1000, which is done by multiplying both the numerator and denominator by 200

The numerators can be subtracted and the denominators stay the same. 203 - 200 = 3

4 Circle the correct statement.

[1 mark]

[✓ $3x \equiv x + 2x$] $3x \equiv 2$ $3x + x \equiv 2 - x$ $3x + x - 2 \equiv 0$

The three lines means equivalent to, meaning that both sides are identical no matter what x is

5 Divide 62 in the ratio 3 : 7

[3 marks]

$3+7$ ← There is 62 in total. This is represented by a total of 10 parts in the ratio

$62 \div 10$ ← Dividing the 62 by the 10 parts which represent it works out that 1 part of the ratio is worth 6.2

$$\begin{array}{r} 6.2 \\ \times\ 3 \\ \hline 18.6 \end{array}$$

$$\begin{array}{r} 6.2 \\ \times\ 7 \\ \hline 43.4 \end{array}$$

Multiplying the value of 1 part of the ratio by the 3 parts and 7 parts works out the value of the 3 parts and 7 parts

Answer 18.6 and 43.4

Turn over for the next question

7

Turn over ▶

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6 Here is some information about the time spent on social media by 40 women and 40 men last week.

Time spent, t (hours)	**Number of women**	**Number of men**
$2 < t \leqslant 5$	12	10
$5 < t \leqslant 8$	11	17
$8 < t \leqslant 11$	14	9
$11 < t \leqslant 14$	2	4
$14 < t \leqslant 17$	1	0

Tick **one** box for each statement.

[3 marks]

	Definitely true	**Might be true**	**Cannot be true**
Three of the **women** spent more than 11 hours on social media.	☑	☐	☐
The range for the **men** is 15 hours.	☐	☐	☑
The women have a higher median than the men.	☐	☑	☐

$\frac{40+1}{2}$

Using the formula (n + 1)/2, where n is the number of women or men, works out that the median value is halfway between the 20th and 21st value

$20-12=8$

$20-10=10$

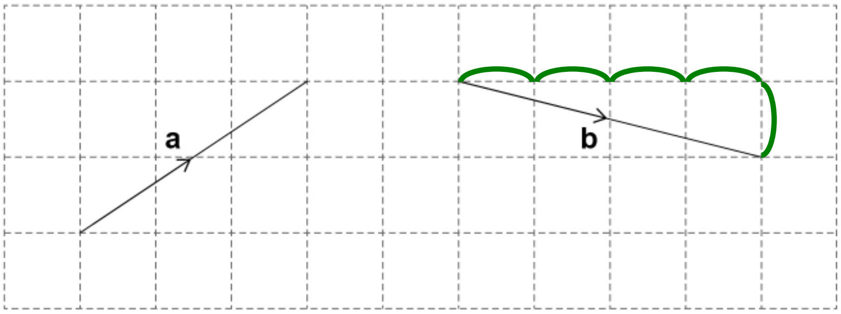
Counting to the 20th for each the men and women. Subtracting the frequency of the first category works out that both medians are in the second category as the frequency of the second categories is more than is left to be counted

The women in 11 < t ⩽ 14 and 14 < t ⩽ 17 spent more than 11 hours. Adding the frequencies for these works out that there are three women who spent more than 11 hours so the first statement must be true. The range for the men must be less than 12 as the greatest possible time is 14 hours, the lowest possible time must be more than 2 hours and 14 - 2 = 12, so the second statement cannot be true. The medians for both the men and women are both in 5 < t ⩽ 8 so the third statement might be true

Do not write outside the box

7 The diagram shows the vectors **a** and **b**.

As a column vector $\mathbf{a} = \begin{pmatrix} 3 \\ 2 \end{pmatrix}$



7 (a) What is **b** as a column vector?

[2 marks]

b is 4 to the right and 1 down so is 4 in the x-direction and -1 in the y-direction

Answer $\begin{pmatrix} 4 \\ -1 \end{pmatrix}$

7 (b) Work out 4**a** as a column vector.

[1 mark]

Multiplying the x and y-components of a by 4. 4 x 3 = 12. 4 x 2 = 8

Answer $\begin{pmatrix} 12 \\ 8 \end{pmatrix}$

7 (c) $\mathbf{a} + \mathbf{c} = \begin{pmatrix} 3 \\ 0 \end{pmatrix}$

Work out **c** as a column vector.

Circle your answer.

[1 mark]

$\begin{pmatrix} 2 \\ 0 \end{pmatrix}$ $\begin{pmatrix} 0 \\ 2 \end{pmatrix}$ $\begin{pmatrix} -2 \\ 0 \end{pmatrix}$ [✓ $\begin{pmatrix} 0 \\ -2 \end{pmatrix}$]

Adding the x-components of a and the circled vector: 3 + 0 = 3. Adding the y-components of a and the circled vector: 2 + -2 = 0. So it must be the circled vector as adding it to a gives the desired vector

7

Turn over ▶

8 Work out $\left(\frac{7}{10} - \frac{4}{15}\right) \div \frac{2}{3}$

Give your answer as a fraction.

[3 marks]

$\frac{21}{30} - \frac{8}{30}$

First dealing with the (7/10 - 4/15). The denominators of both fractions need to be the same so that the fractions can be subtracted. 30 is a common multiple of 10 and 15 so multiplying both the numerator and denominator of the first fraction by 3 and both the numerator and denominator of the second fraction by 2 to get 30 as a common denominator

$\frac{13}{30} \times \frac{3}{2}$

The numerators of both fractions can be subtracted and the denominator stays the same so 21/30 - 8/30 = 13/30. To divide this by 2/3, the division is changed to a multiply and the 2/3 is flipped

To multiply fractions, the numerators can be multiplied and the denominators can be multiplied. 13 x 3 = 39 and 30 x 2 = 60. There is no need to simplify the fraction

Answer $\frac{39}{60}$

9 Work out all the **integer** values of x for which $12 \leqslant 4x < 25$

[2 marks]

$4\overline{)12\,{}^{2}5}$ with $0\ 6\,r1$ above

Dividing all sides of the inequality by 4 gets x on its own in the middle

$3 \leq x < 6\frac{1}{4}$

12 ÷ 4 = 3. The remainder of 1 when dividing 25 by 6 is left as a fraction

The smallest integer (not decimal or fraction) x can be is 3 and the largest integer it can be is 6. It can also be anything between these

Answer 3,4,5,6

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10 Here is some information about 120 people who visit a shop.

$\frac{3}{4}$ of the people buy neither a coat nor a dress.

19 people buy a coat.

14 people buy a dress.

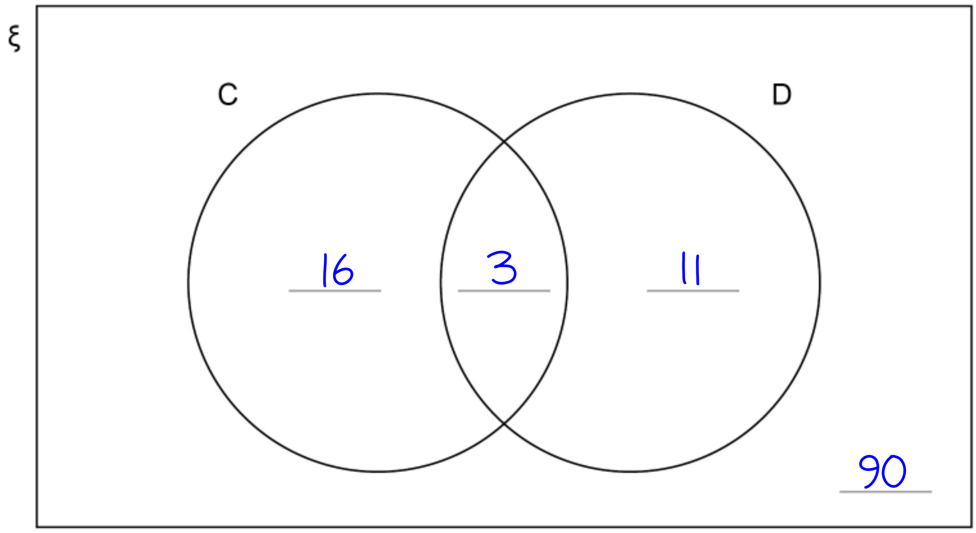
Complete this Venn diagram to represent the information.

[3 marks]

ξ = 120 people who visit the shop

C = people who buy a coat

D = people who buy a dress



$$4\overline{)1^{1}2^{2}0}\quad 030$$

This works out that 1/4 of 120 is 30

30×3

Multiplying the 30 by 3 works out that 3/4 of the 120 is 90, so this many buy neither a coat nor a dress

$$\begin{array}{r} 90 \\ +19 \\ +14 \\ \hline 123 \\ -120 \\ \hline 3 \end{array}$$

Adding the 90, 19 and 14 works out that there would be 123 people in total if there was nobody bought both a coat and a dress. This is 3 more than the 120 people who visit the shop. Therefore 3 must buy both a coat and a dress as every 1 put in the centre reduces the total by 1

19 - 3 = 16 so this many must buy only a coat.
14 - 3 = 11 so this many must buy only a dress

8

11 Write $(3^6 \times 3^5) : 3^7$ in the form $n : 1$ where n is an integer.

[3 marks]

$3^{11} : 3^7$

$a^x \times a^y = a^{x+y}$ so $3^6 \times 3^5 = 3^{6+5} = 3^{11}$

$3^{11} \div 3^7 = 3^4$

Dividing both sides by 3^7 gets 1 on the right side of the ratio. $a^x \div a^y = a^{x-y}$ so $3^{11} \div 3^7 = 3^{11-7} = 3^4$

3, 9, 27

$$\begin{array}{r} 27 \\ \times\ 3 \\ \hline 8_{2}1 \end{array}$$

Listing out the powers of 3 by keep multiplying by 3 until it reaches the fourth one

Answer 81 : 1

12 a is 10% more than b.

Circle the ratio $a : b$

[1 mark]

10 : 11 10 : 1 [✓ 11 : 10] 1 : 10

11 is 10% more than 10. a could by 11 and b could be 10

13 Work out $0.4\dot{7} + 0.312$

Circle your answer.

[1 mark]

0.782 0.789 [✓ $0.789\dot{7}$] $0.7\dot{8}\dot{9}$

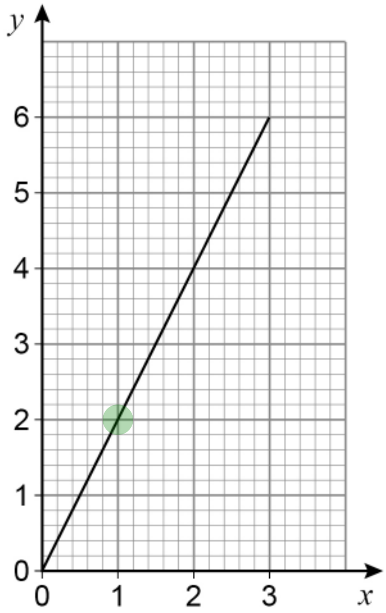
$$\begin{array}{r} 0.477\dot{7} \\ +\,0.3120 \\ \hline 0.789\dot{7} \end{array}$$

Repeating the 7 so that the recurring digit is added to a 0

14 Craig wants to draw a graph, for values of x from –3 to 3,

where the x-coordinate and y-coordinate are always in the ratio 2 : 1

Here is his graph.



Make two criticisms of Craig's graph.

[2 marks]

Criticism 1 x = 1 and y = 2 is not in the ratio 2 : 1

The highlighted point has the coordinates (1 , 2). The x-coordinate and y-coordinate are not in the ratio 2 : 1, they are in the ratio 1 : 2

Criticism 2 Is not drawn for values of x from -3 to 3

It is only drawn for values of x from 0 to 3

7

15 Show that $(3x + 4)(2x - 5) - 11x(x - 2) + 5(x^2 - 3x - 1)$ simplifies to an integer.

[4 marks]

$6x^2 - 15x + 8x - 20 - 11x^2 + 22x + 5x^2 - 15x - 5$ ← Expanding all the brackets

-25 ← Collecting like terms to simplify. The x^2 terms cancel out and the x terms cancel out

Do not write outside the box

16 A graph has the equation $y = x^2 + px + r$ where p and r are constants.

The graph passes through the points (0, 4), (1, 3) and (8, w)

Work out the value of w.

[4 marks]

$4 = r$ ← Substituting in the x and y-coordinates of the point (0 , 4) into the equation gives $4 = 0^2 + p(0) + r$. $0^2 = 0$ and $p(0) = 0$ so it just becomes $4 = r$

$3 = 1 + p + 4$ ← Substituting in the x and y-coordinates of the point (1 , 3) and the value of r into the equation gives $3 = 1^2 + p(1) + 4$. $1^2 = 1$ and $p(1) = p$

$-2 = p$ ← $1 + 4 = 5$. Then subtracting 5 from both sides

$w = 8^2 - 2(8) + 4$ ← Substituting in the x and y-coordinates of the point (8 , w) and the values of r and p into the equation

$= 64 - 16 + 4$ ← $8^2 = 64$. $-2(8) = -16$

$-16 + 4 = -12$. $64 - 12 = 52$

$w =$ 52

Turn over for the next question

8

Turn over ▶

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17 The table shows information about the heights of 60 athletes.

Height, h (cm)	**Frequency**
$150 < h \leqslant 160$	4
$160 < h \leqslant 170$	12
$170 < h \leqslant 180$	35
$180 < h \leqslant 190$	7
$190 < h \leqslant 200$	2

17 (a) Complete the cumulative frequency table.

[1 mark]

$$\begin{array}{r} 16 \\ +35 \\ \hline 51 \end{array}$$

Height, h (cm)	**Cumulative frequency**
$h \leqslant 150$	0
$h \leqslant 160$	4
$h \leqslant 170$	16
$h \leqslant 180$	51
$h \leqslant 190$	58
$h \leqslant 200$	60

16 + 35

51 + 7

58 + 2

Adding the frequencies up as they go

17 (b) Circle the class interval that contains the lower quartile.

[1 mark]

$150 < h \leqslant 160$ [✓ $160 < h \leqslant 170$] $170 < h \leqslant 180$ $180 < h \leqslant 190$

$60+1$

$$\begin{array}{r} 15\frac{1}{4} \\ 4\overline{)6^{2}1} \end{array}$$

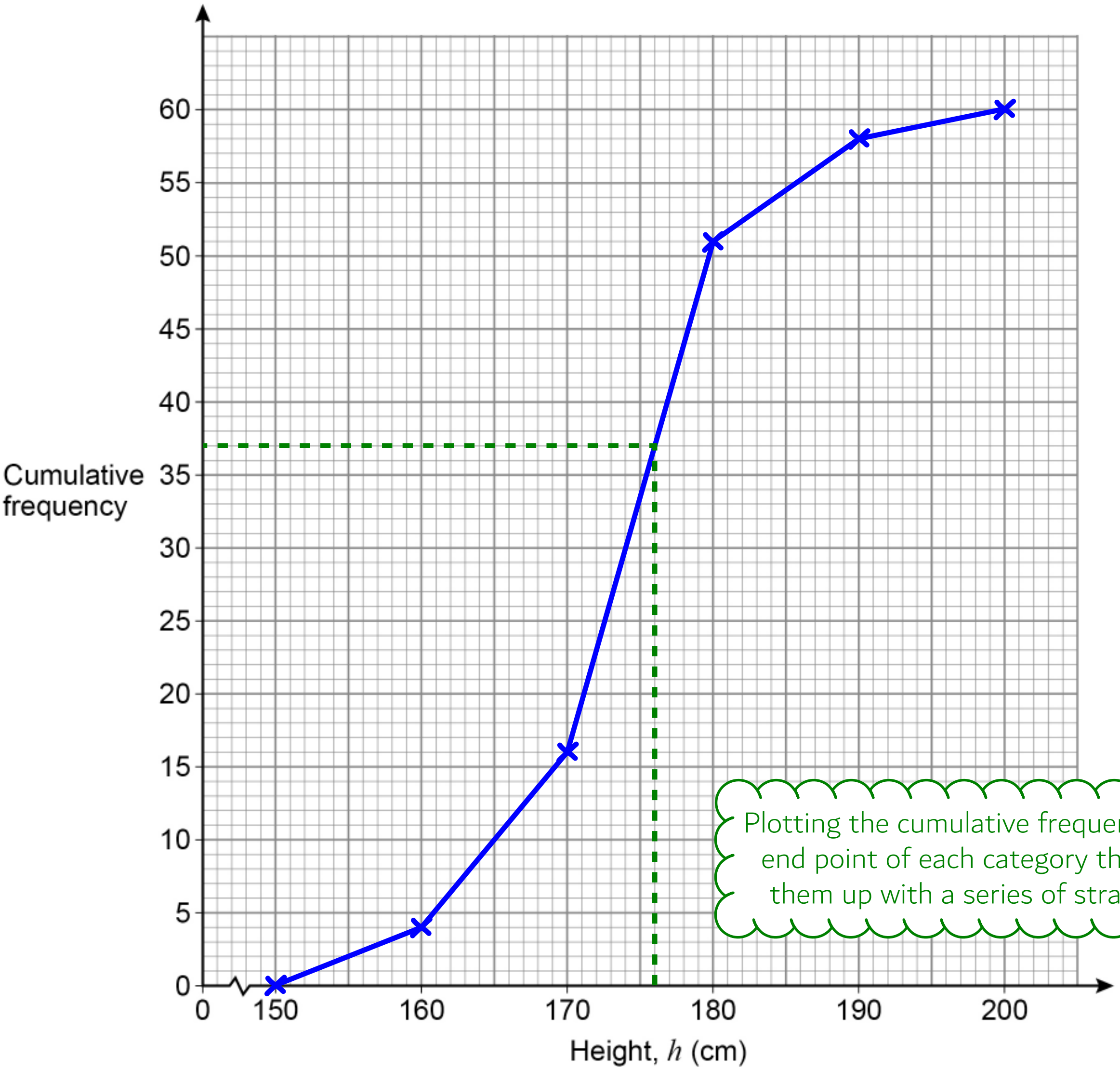
Using the formula (n + 1)/4, where n is the number of athletes, works out that the lower quartile is between the 15th and 16th value

$15-4=11$

Counting up to the 15th. Counting the first 4 leaves another 11 to be counted. Another 12 cannot be counted so the 15th must be in 160 < h ⩽ 170. The 16th is also in this category. Therefore the lower quartile must be in this category

17 (c) Draw a cumulative frequency diagram to represent the data.

[2 marks]



Plotting the cumulative frequencies at the end point of each category then joining them up with a series of straight lines

17 (d) Estimate the number of the athletes whose height is **more** than 176 cm

[2 marks]

$$\begin{array}{r} \overset{5}{\cancel{6}}\overset{1}{0} \\ -37 \\ \hline 23 \end{array}$$

Reading up from the height of 176cm to the line then across estimates that there are 37 athletes who have a height of 176cm or less. Subtracting this from the 60 athletes works out that an estimate of 23 have a height more than 176cm

Answer 23

6

Turn over ▶

18 A road has three sections, D, E and F.

The lengths of D, E and F are in the ratios

D : E = 3 : 5 E : F = 7 : 4

What fraction of the length of the road is section D?

[3 marks]

D	E	F
3	5	
	7	4
21	35	20

Combining the ratios by making the same number of parts for E. A common multiple of 5 and 7 is 35 so both halves of the first ratio can be multiplied by 7 and both halves of the second ratio can be multiplied by 5 to get this

$$\begin{array}{r} 21 \\ +35 \\ +20 \\ \hline 76 \end{array}$$

Adding up the number of parts works out that there are 76 parts in total in the combined ratio

21 out of the 76 parts are D

Answer $\frac{21}{76}$

Do not write outside the box

19 (a) Work out the value of $\left(\frac{5}{4}\right)^{-2}$

[2 marks]

$\frac{25}{16}$ ← Applying the power of 2 so squaring the numerator and denominator

Applying the negative power so doing the reciprocal, which flips the fraction

Answer $\frac{16}{25}$

19 (b) Work out the value of $\left(\frac{9}{100}\right)^{\frac{3}{2}}$

[2 marks]

$\frac{3}{10}$ ← The 2 is the denominator of the power so square rooting both the numerator and denominator of 9/100

Applying the power of 3 so cubing the numerator and denominator

Answer $\frac{27}{1000}$

Turn over for the next question

7

Turn over ▶

Do not write outside the box

20 The only solution to $x^2 + bx + c = 0$ is $x = -15$

Work out the values of b and c.

[3 marks]

$(x+15)(x+15)$

To solve a quadratic, it can be factorised. If the only solution is x = -15, the factorised form must have been (x + 15)(x + 15) = 0

$$\begin{array}{r} 15 \\ \times 15 \\ \hline 75 \\ 150 \\ \hline 225 \end{array}$$

Part of the expansion will be 15 x 15

$x^2+15x+15x+225$

Expanding the brackets

$b =$ 30 $c =$ 225

The expanded and simplified form is $x^2 + 30x + 225 = 0$

21 Convert $0.6\dot{1}$ to a fraction.

[3 marks]

$x=0.6\dot{1}$

Let x be the recurring decimal

$10x=6.1\dot{1}$

There is 1 recurring digit so multiplying by 10 once allows the recurring digit to be written in the same decimal place

$$\begin{array}{r} {}^{5}\cancel{6}.{}^{1}1\dot{1} \\ -0.6\dot{1} \\ \hline 5.50 \end{array}$$

$9x=5.5$

Subtracting x from 10x leaves 9x

$x=\frac{5.5}{9}$

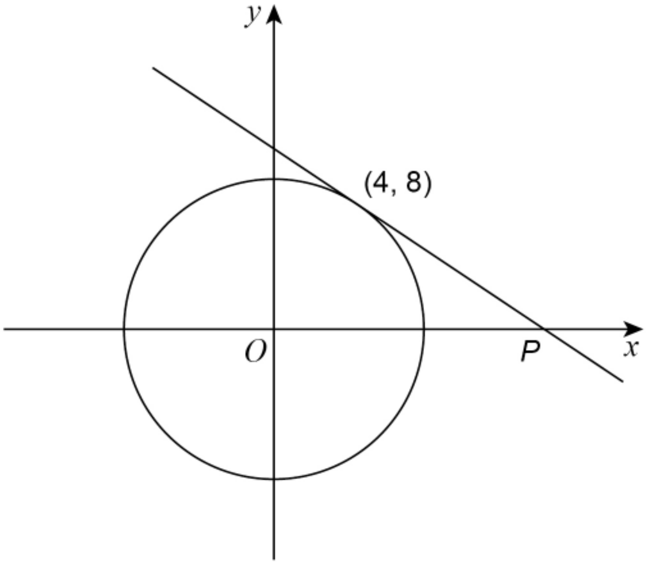
Dividing both sides by 9 expresses x as a fraction

Both the numerator and denominator are multiplied by 10 to eliminate the decimals within the fraction

Answer $\frac{55}{90}$

22 (4, 8) is a point on a circle, centre O.

The tangent at (4, 8) intersects the x-axis at P.



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Work out the x-coordinate of P.

[5 marks]

First find the equation of the tangent. It is a straight line so its equation must be in the form y = mx + c, where m is the gradient and c is the y-intercept

$\frac{8-0}{4-0}=\frac{8}{4}=2$

Gradient = (change in y)/(change in x). The only points given are the centre of the circle (0 , 0) and point (4 , 8). The line connecting both of these points is the radius. Working out the gradient of the radius. Change in y is 8 - 0 and change in x is 4 - 0

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

The tangent is perpendicular to the radius so its gradient must be the negative reciprocal, which is -1/2. Substituting the gradient into the general equation of a straight line

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

$=8+\frac{1}{2}(4)$

$=10$

Rearranging to find c by adding 1/2 x to both sides. Then substituting in the x and y-coordinate of the point (4 , 8) finds that c is 10

$0-10=-\frac{1}{2}x$

Rearranging to find x. First subtracting c from both sides and substituting in the y-coordinate of the point P (which must be 0 as it is on the x-axis) and the value of c

$10=\frac{1}{2}x$

0 - 10 = -10. Flipping the signs on both sides gets rid of the negatives

Multiplying both sides by 2 gets rid of the 1/2 and finds that x = 20

Answer 20

11

Turn over ▶

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23 $4 \times \sin 30° \times \tan 30° \times \cos 30° = \sin y$

Work out **one** possible value of y.

You **must** show your working.

[4 marks]

0	30	45	60	90
0	1	2	3	4
4	3	2	1	0

Writing the angles 0, 30, 45, 60, 90 and 0, 1, 2, 3, 4 under these for the sin values and 4, 3, 2, 1, 0 under these for the cos values

$$\frac{1}{2} \div \frac{\sqrt{3}}{2} = \frac{1}{2} \times \frac{2}{\sqrt{3}} = \frac{1}{\sqrt{3}}$$

Working out tan30 by dividing sin30 by cos30. Sin30 is found by square rooting the 1 and putting it over 2. Cos30 is found by square rooting the 3 and putting it over 2

$$4 \times \frac{1}{2} \times \frac{1}{\sqrt{3}} \times \frac{\sqrt{3}}{2} = 1$$

Substituting in the exact values for sin30, tan30 and cos30 finds that it is all equal to 1

Answer 90 degrees

Sin90 = 1. This is found by square rooting the 4 and putting it over 2

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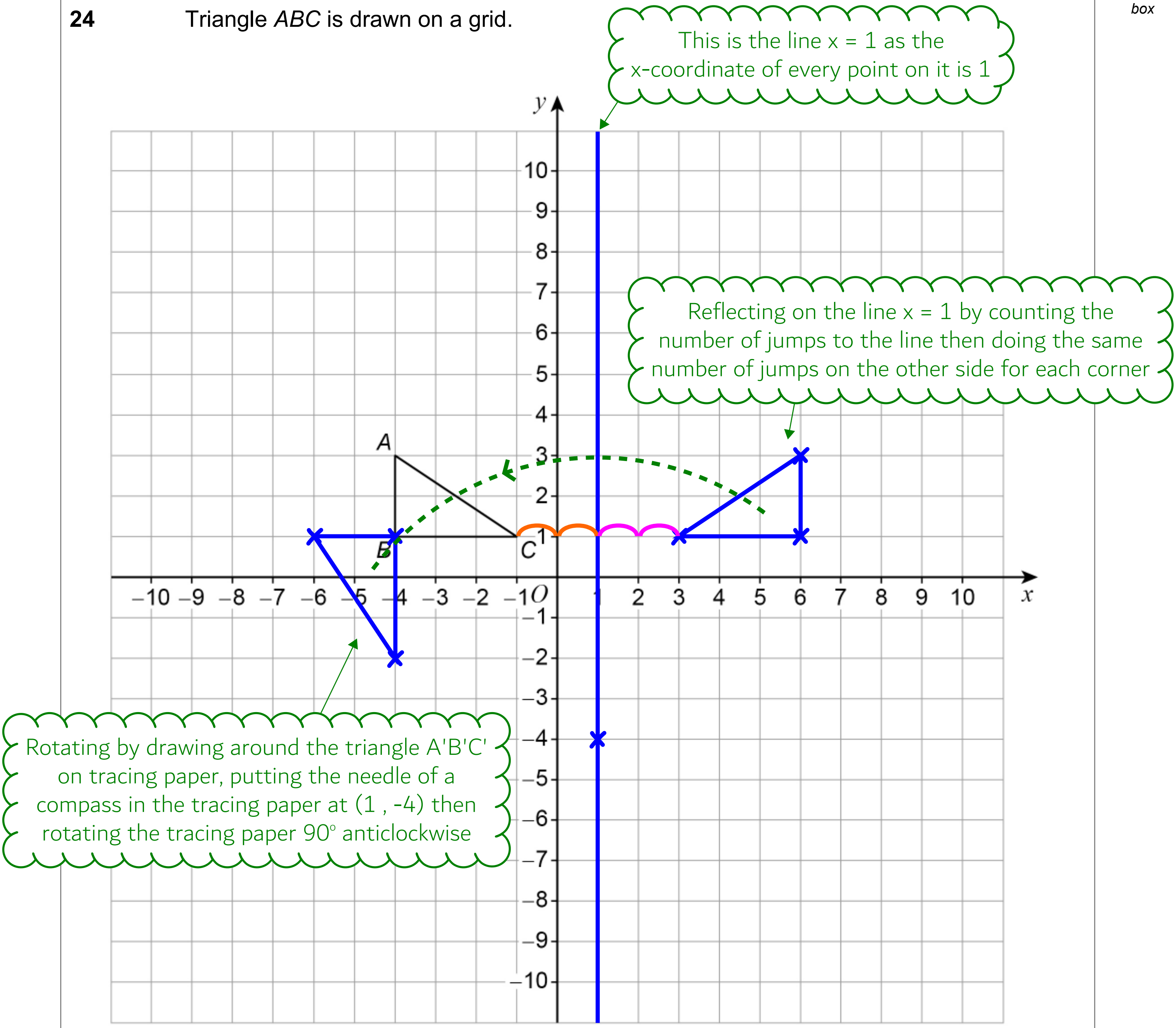
24 Triangle *ABC* is drawn on a grid.



ABC is transformed to *A'B'C'* by a reflection in the line $x = 1$

A'B'C' is transformed to *A''B''C''* by a rotation 90° anticlockwise about (1, –4)

Which **one** point on *ABC* is invariant under the combined transformation?

You **must** show the result of each transformation on the grid.

[4 marks]

Answer B

Point B is invariant as it is in the same place

8

25 (a) Solve $x^2 - 5x - 6 < 0$

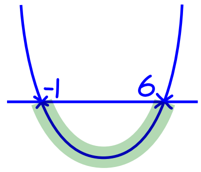
[2 marks]

$(x-6)(x+1)=0$

Solving when it is equal to 0 by factorising. -6 and 1 multiply to -6 and add to -5 so putting these in brackets with x

$x=6$ or $x=-1$

One of the brackets must be equal to 0 in order to multiply to 0. If x - 6 = 0, x = 6 or if x + 1 = 0, x = -1



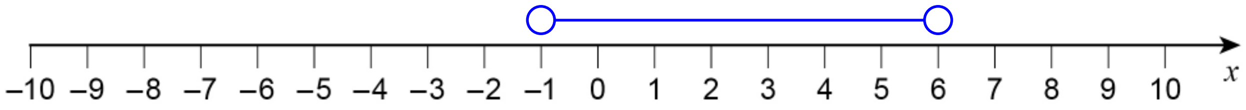
Sketching the quadratic. It is u-shaped as it is positive x^2

Answer $-1<x<6$

The highlighted part of the line is where it is less than 0 in the y-direction

25 (b) Show the solution to $x^2 - 5x - 6 < 0$ on the number line.

[1 mark]



The open circles mean it cannot be equal to the values they are above. The line between them indicates that it is all values between them

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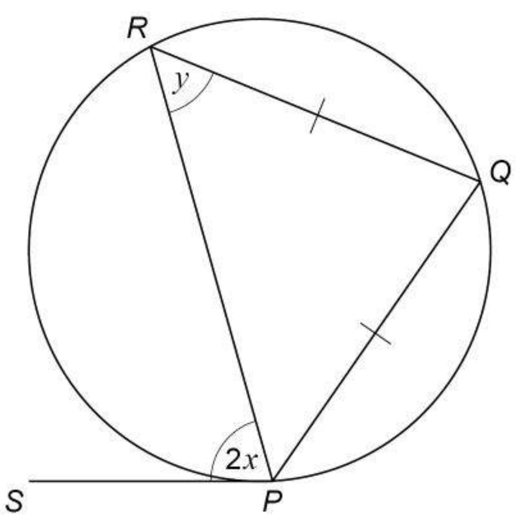
26 P, Q and R are points on a circle.

SP is a tangent to the circle.

$RQ = PQ$



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Prove that $y = 90° - x$

[4 marks]

Angle RQP = 2x due to the alternate segment theorem

The angle between a tangent and a chord is equal to the interior opposite angle (the one opposite the chord in the triangle)

(180 - 2x) ÷ 2

Angle PRQ = 90 - x as angles in a triangle add up to 180, triangle RQP is isosceles as it has two equal sides and its base angles are equal

The base angles are opposite the equal sides. Subtracting angle RQP from the 180 leaves the total of angles PRQ and RPQ. As they are both equal, this total can be divided by 2 to express angle PRQ

Therefore y = 90 - x

As angle PRQ is both y and 90 - x

7

Turn over ▶

Do not write outside the box

27 Work out $\sqrt{2\frac{13}{16}} - \frac{2}{\sqrt{5}}$

Give your answer in the form $\frac{a\sqrt{5}}{b}$ where a and b are integers.

[4 marks]

$$\begin{array}{r} 16 \\ \times\ 2 \\ \hline 32 \\ +13 \\ \hline 45 \end{array}$$

Converting the mixed fraction into an improper fraction by multiplying the 2 by the 16 and adding the result to the 13

$$\sqrt{\frac{45}{16}} = \frac{\sqrt{45}}{4} = \frac{3\sqrt{5}}{4}$$

Replacing the mixed fraction with 45/16 and square rooting both the numerator and denominator. Simplifying $\sqrt{45}$ by using $\sqrt{a} \times \sqrt{b} = \sqrt{ab}$ to split it into $\sqrt{9} \times \sqrt{5}$, which is $3\sqrt{5}$

$$\frac{2\sqrt{5}}{5}$$

Rationalising the denominator of $2/\sqrt{5}$ by multiplying both the numerator and denominator by $\sqrt{5}$

$$\frac{15\sqrt{5}}{20} - \frac{8\sqrt{5}}{20}$$

Subtracting the fractions by making the denominators the same. Multiplying the numerator and denominator of $3\sqrt{5}/4$ by 5 and of $2\sqrt{5}/5$ by 4 to get 20 as a common denominator

The numerators are subtracted and the denominator stays the same

Answer $\frac{7\sqrt{5}}{20}$

END OF QUESTIONS

4

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