

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

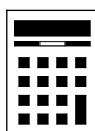
Paper 3 Calculator

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a calculator
- mathematical instruments
- the Formulae Sheet (enclosed).



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.

Do not write
outside the
box

1 Circle the smallest number.

[1 mark]

4.31 4. $\dot{3}$ 4.301 4.33

4.310 4.333 4.301 4.330

Writing each number to 3 decimal places makes it more clear which is the smallest

2 Work out $\begin{pmatrix} -4 \\ 8 \end{pmatrix} - \begin{pmatrix} 3 \\ -2 \end{pmatrix}$

Circle your answer.

[1 mark]

$\begin{pmatrix} -7 \\ 10 \end{pmatrix}$ $\begin{pmatrix} -7 \\ 6 \end{pmatrix}$ $\begin{pmatrix} -1 \\ 10 \end{pmatrix}$ $\begin{pmatrix} -1 \\ 6 \end{pmatrix}$

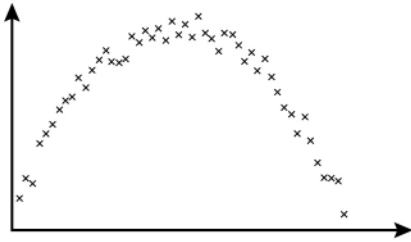
$$\begin{array}{l} -4 - 3 = -7 \\ 8 - -2 = 10 \end{array}$$

So the x-component must be -7 and the y-component must be 10

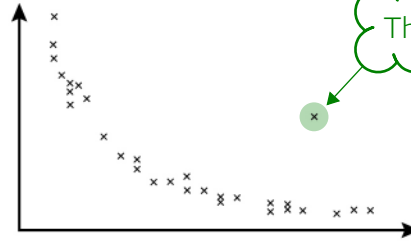


3 Here are four scatter graphs.

Graph A

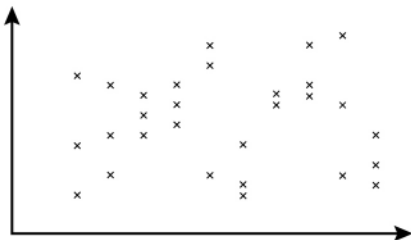


Graph B

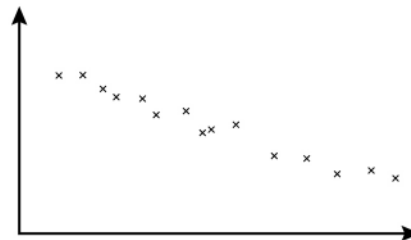


This point is an outlier

Graph C



Graph D



3 (a) For which graph is a straight line of best fit appropriate?
Circle your answer.

[1 mark]

A

B

C

D

3 (b) Which graph has **one** outlier?
Circle your answer.

[1 mark]

A

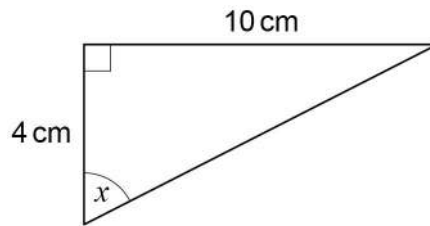
B

C

D



4

Use trigonometry to work out the size of angle x .Not drawn
accurately

[3 marks]

$$\overset{\circ}{S} \overset{\circ}{H} \overset{\circ}{C} \overset{\circ}{A} \overset{\circ}{H} \overset{\circ}{T} \overset{\circ}{A}$$

Writing the formula triangles for right-angled trigonometry. S: sin of the angle. C: cos of the angle. T: tan of the angle. O: opposite. H: hypotenuse. A: adjacent. Ticking O as the 10cm is the opposite (it is opposite the angle x). Ticking A as the 4cm is the adjacent (it is next to the angle x and is not the hypotenuse). The hypotenuse is the longest side

$$\tan x = \frac{10}{4}$$

$$x = \tan^{-1}\left(\frac{10}{4}\right)$$

There are two ticks on the TOA formula triangle so this one can be used. Tan of the angle involves the angle so covering over t finds that $\tan x = \text{opposite/adjacent}$

$$x = \underline{\hspace{2cm} 68.2 \hspace{2cm}}^{\circ}$$

Rearranging to make x the subject by doing the opposite of tan (inverse tan) to both sides



5

Laura works in a shop.

The table shows the number of hours she works on two weekends.

	Saturday	Sunday
Weekend 1	3	2
Weekend 2	$5\frac{1}{2}$	$3\frac{1}{2}$

Work out the percentage increase in her **total** hours from Weekend 1 to Weekend 2**[3 marks]**

$$3 + 2 = 5$$

Adding the hours done on Saturday and Sunday for Weekend 1 works out that 5 hours were worked in total on Weekend 1

$$5\frac{1}{2} + 3\frac{1}{2} = 9$$

Adding the hours done on Saturday and Sunday for Weekend 2 works out that 9 hours were worked in total on Weekend 2

$$\frac{9-5}{5} \times 100$$

9 - 5 expresses the difference in the number of hours between both of the weekends and therefore how many hours it increased by. Putting this over the 5 expresses the increase as a fraction of the original. Multiplying this fraction by 100 converts it into a percentage

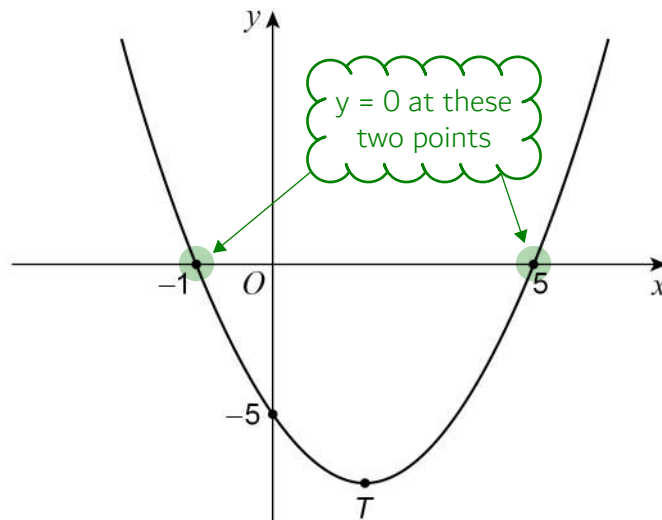
Answer 80 %

Turn over for the next question

Turn over ►



- 6 Here is a sketch of the curve $y = x^2 - 4x - 5$



- 6 (a) Write down the **two** roots of $x^2 - 4x - 5 = 0$

[1 mark]

Answer -1 and 5

y has been replaced with 0 in the equation. It is basically asking what the values of x are when $y = 0$

- 6 (b) Work out the coordinates of T, the turning point of the curve.

[2 marks]

This is a quadratic graph and they are symmetrical. So the x-coordinate of the turning point must be halfway between the two roots

$5 - 1$
 $4 \div 2$ ← Adding 5 and -1 then dividing by 2 works out the mean of the two roots and therefore works out that the x-coordinate of the turning point is 2

$$2^2 - 4 \times 2 - 5$$

Answer (2 , -9)

Substituting in the x-coordinate into the equation finds that the y-coordinate must be -9



7

A is an **arithmetic** progression.

Here are the first four terms.

13 16 19 22

G is a **geometric** progression.

Here are the first four terms.

2 4 8 16

$$n\text{th term of A} = 8\text{th term of G}$$

Work out the value of n .**[4 marks]**

32, 64, 128, 256

Geometric means that it multiplies by the same amount between each term. G is multiplying by 2 between each term. Continuing to multiply by 2 works out that the 8th term of G is 256

 $3n + 10 = 256$

The n th term of A is $3n + 10$. It must be $3n$ as it increases by 3 between each term. It must be $+10$ as the 0th term (the one before the first term) would be 10. Setting the n th term of A equal to the 8th term of G

 $3n = 246$

Subtracting 10 from both sides to get the n term on its own

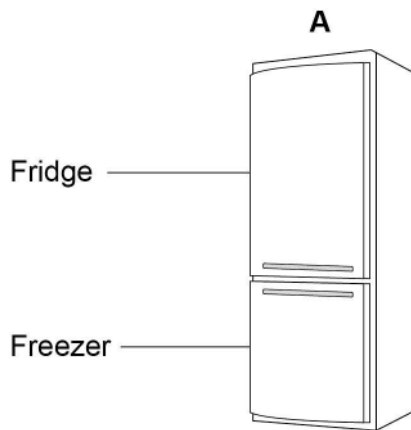
$$n = \underline{\hspace{2cm} 82 \hspace{2cm}}$$

Dividing both sides by 3 gets n on its own

Turn over ►

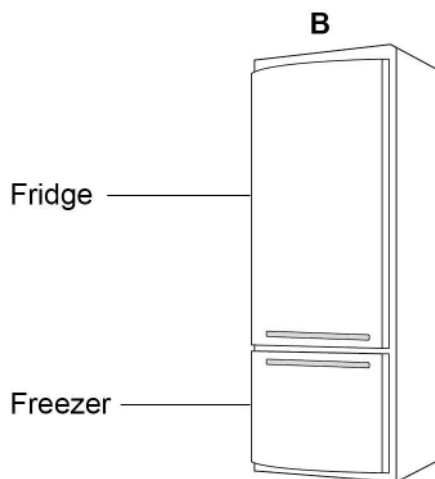


8 Information about two fridge-freezers, A and B, is shown.



Total capacity is 330 litres

fridge capacity : freezer capacity = 3 : 2



Fridge capacity is 294 litres

fridge capacity : freezer capacity = 7 : 3



Grace buys one of these fridge-freezers.
She buys the one with the greater **freezer** capacity.

Which one does she buy?

You **must** show your working.

[4 marks]

$$3+2$$

The total capacity of A is given. $3 + 2$ works out that there are 5 parts in total for the ratio of A

$$330 \div 5$$

Dividing the total capacity of A by 5 works out that 1 part of the ratio is worth 66

$$66 \times 2 = 132$$

Multiplying the value of 1 part of the ratio by 2 works out what 2 parts of the ratio represent, which is the capacity of the freezer of A

$$294 \div 7$$

7 parts of the second ratio represent the fridge capacity of B. Dividing the fridge capacity of B by 7 works out that 1 part of the ratio is worth 42

$$42 \times 3 = 126$$

Multiplying the value of 1 part of the second ratio by 3 works out what 3 parts of the ratio represent, which is the capacity of the freezer of B

Answer _____ A _____

The freezer capacity of A (which is 132 litres) is more than the freezer capacity of B (which is 126 litres)

Turn over for the next question



9

Tom and Adil are the two runners in a 200-metre race.

Tom completes the race in 24 seconds.

Adil completes the race at an average speed of 28.8 kilometres per hour.

Who wins the race?

You **must** show your working.

[3 marks]

$$200 \div 1000 = 0.2$$

There are 1000 metres in a kilometre so dividing the 200 metres by 1000 converts it into 0.2 kilometres

$$24 \div 60$$

There are 60 seconds in a minute so dividing the 24 seconds by 60 converts it into 0.4 minutes

$$0.4 \div 60$$

There are 60 minutes in an hour so dividing the 0.4 minutes by 60 converts it into $\frac{1}{150}$ hours

$$0.2 \div \frac{1}{150} = 30$$

Dividing the distance in kilometres by the time in hours finds Tom's speed in kilometres per hour

Answer _____

Tom

Tom had a greater average speed so must have won the race



10 The mass of a baby is 3.6 kilograms to 1 decimal place.

What is the error interval for the mass in kilograms?

Tick **one** box.

[1 mark]

$$3.5 \leq \text{mass} \leq 3.6$$

$$3.55 \leq \text{mass} \leq 3.65$$

$$3.5 \leq \text{mass} < 3.6$$

$$3.55 \leq \text{mass} < 3.65$$

The mass of the baby could be equal to 3.55 as this rounds to 3.6. The mass of the baby could not be equal to 3.65 as this rounds to 3.7

$$3.6 \pm \frac{0.1}{2}$$

Adding and subtracting half of the resolution of the measurement works out the upper and lower bounds of the measurement. The resolution is 0.1 as this is what the first decimal place goes up by. So the lower bound is 3.55 and the upper bound is 3.65

11 A quadrilateral has angles 70° , 110° , 130° and 50°

Circle the possible type of quadrilateral.

[1 mark]

kite

parallelogram

rhombus

trapezium

Two of the angles in a kite are equal. The opposite angles in a parallelogram and rhombus are equal. A trapezium does not have to have any equal angles and none of the angles given are equal

Turn over for the next question

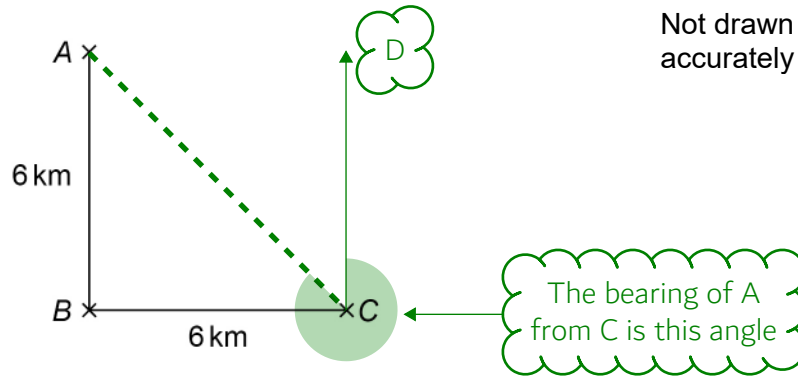


12 (a) B is

6 km due South of A

and

6 km due West of C.



Work out the bearing of A from C.

[2 marks]

$180 - 90$

Subtracting angle ABC, which must be 90° , from the 180° in total in a triangle leaves 90° between the other angles

$90 \div 2$

The triangle ABC is isosceles as two of the sides are equal. Therefore the base angles must be equal. Dividing the 90° by 2 works out that angle ACB is 45°

$90 - 45$

Angle DCB is a right angle. Subtracting angle ACB from this finds that angle ACD is 45°

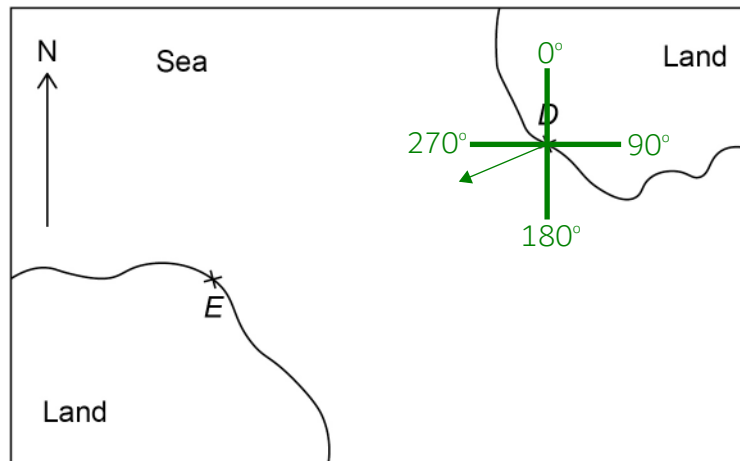
$360 - 45$

Answer 315°

Bearings are the number of degrees turned clockwise from north. It is 45° anticlockwise from C to A so subtracting this from 360° works out the bearing



12 (b) Here is a scale drawing.



A ship is going to sail from D to E .

Mia works out that the ship needs to sail on a bearing of 068°

Why must Mia be wrong?

[1 mark]

The bearing must be more than 180°

The bearing is from D and it is more than 180° clockwise from north to go toward E

13 Simplify $\sqrt{5}a + \sqrt{5}a$

Circle your answer.

[1 mark]

$5a$

$5a^2$

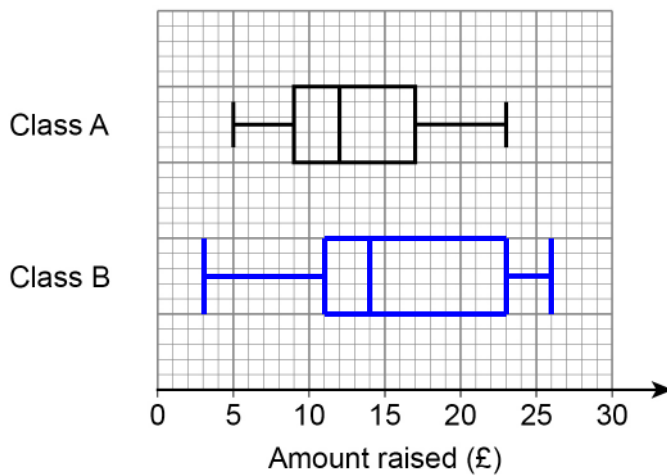
$2\sqrt{5}a$

$\sqrt{10}a$

Let $x = \sqrt{5}a$. $x + x = 2x$ so $\sqrt{5}a + \sqrt{5}a = 2\sqrt{5}a$



- 14 Students in two classes, A and B, raised money for charity.
The box plot for class A is shown on the grid.



For class B,

- the lowest amount was £3 and the highest amount was £26
- the lower quartile was £11
- the median was £2 greater than the class A median
- the interquartile range was $1\frac{1}{2}$ times greater than the class A interquartile range.

Draw the box plot for class B on the grid.

[4 marks]

The median must be £13 as the median of class A is £11 and $11 + 2 = 13$. The interquartile range of class A was 8 as this is the range of the upper (£17) and lower quartile (£9). $1\frac{1}{2} \times 8 = 12$ so the interquartile range of class B is 12. Adding the interquartile range to the lower quartile of 11 works out that the upper quartile is 23



15

A town has

a population density of 278 people per km²

and

a population of 158 460

$$\text{population density} = \frac{\text{population}}{\text{area}}$$

The population increases to 168 720

Work out the population density after the increase.

[3 marks]

$$\frac{168720}{158460} \times 278$$

168720/158460 expresses the fraction the new population is of the original population. Doing this fraction of the 278 works out the new population density. This works as the population density is directly proportional to the population, meaning that whatever the population is multiplied by the population density will be multiplied by the same amount

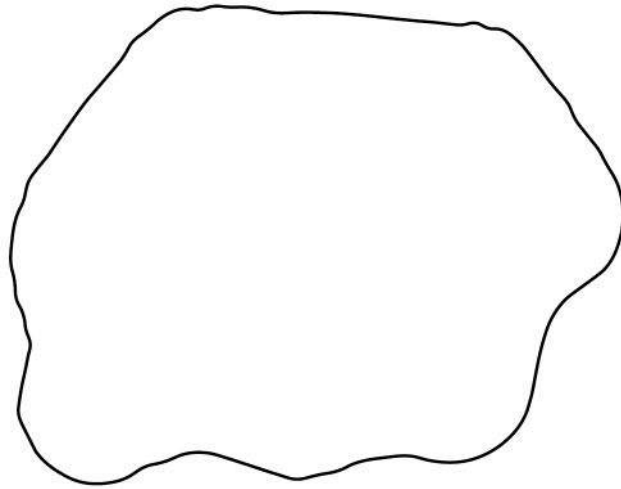
Answer 296 people per km²

Turn over ►



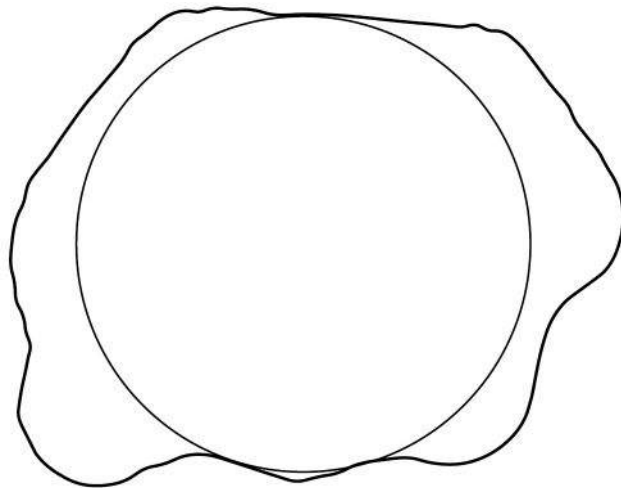
16 Here is a scale drawing of a reservoir.

Scale: 1 cm represents 500 m



Virat wants to estimate the volume of water in the reservoir.

He draws on the scale drawing a circle with radius 3 cm



- 16 (a)** Virat estimates the volume of the reservoir by assuming that
- the reservoir is a cylinder whose cross section is the circle
 - the depth of the reservoir is 17 metres.

Work out Virat's estimate in cubic metres.

[3 marks]

$$3 \times 500$$

Each centimetre represents 500 metres so multiplying the radius of 3cm by 500 works out that it represents 1500m

$$\pi \times 1500^2 \times 17$$

Volume of cylinder = $\pi \times \text{radius}^2 \times \text{height}$.
The radius is 1500m and the height is 17m

Answer 120165919 m³

- 16 (b)** In fact,

- the depth of the reservoir is 13.8 metres
- the reservoir is **not** a cylinder (see diagram).

Which statement about the actual volume of the reservoir is correct?

Tick **one** box.

It is less than Virat's estimate

It is greater than Virat's estimate

It could be less than or greater than Virat's estimate

Give a reason for your answer.

[2 marks]

The area is larger and the depth is less

The reservoir could be treated like a prism. Volume of prism = area of cross section \times length. The area of the cross section is more than the area of the circle meaning that the actual volume could be greater. The depth is the length in the formula and this is less so the actual volume could be less

5

Turn over ►



- 17** In a video game, players make their own character.
They choose one of each from
- 8 faces
 - 4 bodies
 - 5 hairstyles.

- 17 (a)** How many different characters can be made?

[2 marks]

$$8 \times 4 \times 5$$

The product rule for counting can be used. Multiplying the number of outcomes for each event gives the total number of outcomes

Answer _____ 160 _____

- 17 (b)** Two characters are made at random.

What is the probability that they are exactly the same?

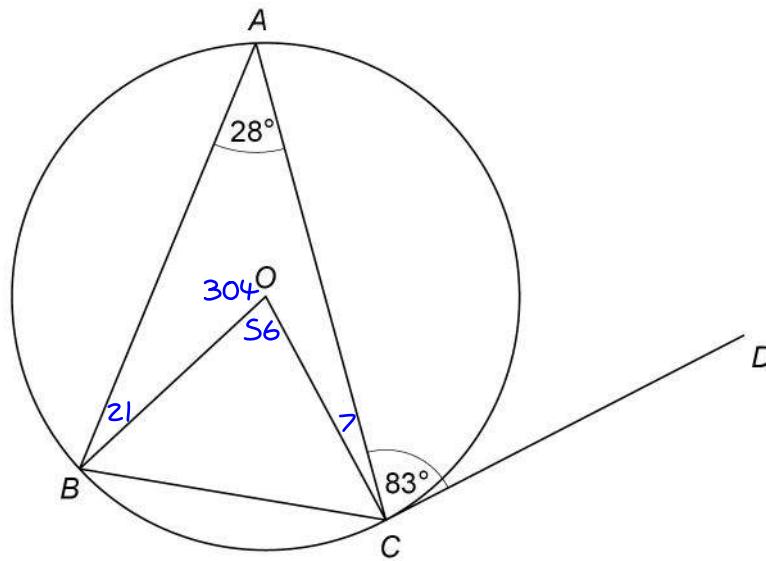
[1 mark]

Answer _____ $\frac{1}{160}$ _____

It is certain to get a character for the first pick. The probability of something which is certain is 1. For the second pick, there is a $\frac{1}{160}$ chance it will be the same as the first one as 1 out of the 160 possibilities is the same. AND means to multiply so $1 \times \frac{1}{160} = \frac{1}{160}$



- 18 A, B and C are points on a circle, centre O .
 DC is a tangent to the circle.



Show that $\text{angle } ABO : \text{angle } ACO = 3 : 1$

[5 marks]

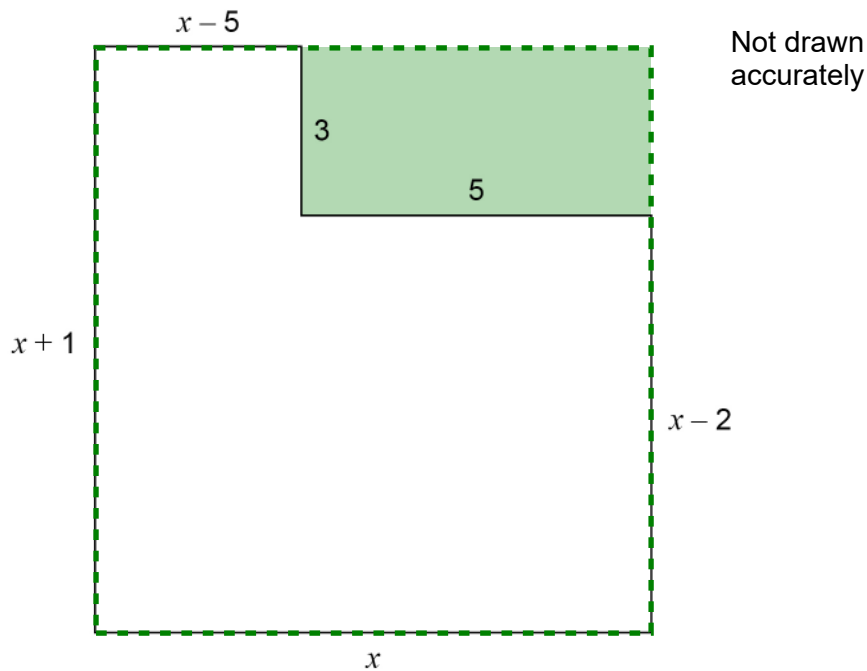
Angle ACO is 7° as the angle between tangent (DC) and radius (OC) is 90° and $90 - 83 = 7$.
Acute angle BOC is 56° as the angle at the centre is double the angle at the circumference and $28 \times 2 = 56$. Reflex angle BOC is 304° as there are 360° around a point and $360 - 56 = 304$.
Angle ABO is 21° as there are 360° in a quadrilateral and $360 - 28 - 7 - 304 = 21$

$$21:7 = 3:1$$

Expressing the ratio of angle ABO : angle ACO
and simplifying by dividing both sides by 7



- 19 Here is the plan of the floor of an L-shaped room.
All lengths are in metres.



- 19 (a) The area of the floor is 75m^2
Show that $x^2 + x - 90 = 0$

[3 marks]

$$x(x+1) - 5 \times 3$$

Expressing the area of the room. Subtracting the area of the rectangle shaded in green from the dashed rectangle leaves the area of the room. Area of rectangle = length \times width

$$x^2 + x - 15 = 75$$

Expanding the brackets and simplifying then setting it equal to the value of the area which is 75m^2

$$x^2 + x - 90 = 0$$

Subtracting 75 from both sides



19 (b) By factorising $x^2 + x - 90$ work out the value of x .

You **must** show your working

[2 marks]

Using table mode, enter $f(x) = 90/x$. Start: 1. End: 30. Step: 1

This lists out the factor pairs of 90. 10 and -9 multiply to -90 and add to 1 (the coefficient of x)

$$(x+10)(x-9) = 0 \quad \leftarrow \text{Factorising by putting the +10 and -9 in brackets with } x$$

$$x = \underline{\hspace{2cm} 9 \hspace{2cm}}$$

There are two brackets multiplied together and the result is 0 so one of the brackets must equal to 0. Either $x + 10 = 0$ or $x - 9 = 0$. $x = -10$ or $x = 9$. x cannot be negative as it is a length so cannot be -10

20 £2448 is invested in an account at a rate of compound interest. One year after the investment there is £2496.96 in the account.

How much is in the account four years after the investment?

[3 marks]

$$\frac{2496.96 - 2448}{2448} \times 100 \quad \leftarrow$$

Subtracting the original amount from the amount after one year works out how much it increased during that year. Putting this over the original amount expresses the increase as a fraction. Multiplying this by 100 converts it into a percentage and works out that the interest rate is 2%

$$2448 \times \left(\frac{100+2}{100}\right)^4 \quad \leftarrow$$

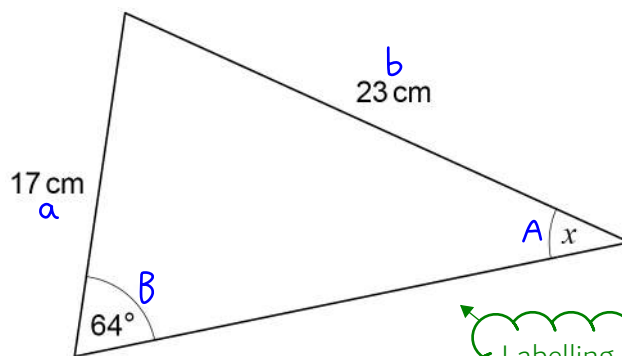
100% is the full amount. Adding 2% to this expresses the percentage it increases to. Putting this over 100 converts it into a fraction, which when multiplied by increases by 2%. Multiplying the original amount by this to the power of 4 as the interest needs to be applied 4 times

Answer £ 2649.79

The answer is rounded to the nearest penny



21

Not drawn
accurately

Labelling the triangle. Side a must be opposite angle A and side b must be opposite angle B

Use the sine rule to work out the size of angle x .

[3 marks]

$$\frac{\sin A}{a} = \frac{\sin B}{b}$$

Writing the sine rule with the angles as numerators

$$\sin A = \frac{a \sin B}{b}$$

Multiplying both sides by a to get rid of it on the left

$$A = \sin^{-1}\left(\frac{a \sin B}{b}\right)$$

Doing the inverse sin of both sides to get A on its own

$$x = \sin^{-1}\left(\frac{17 \sin 64}{23}\right)$$

Substituting in the values

$$x = \underline{\quad 41.6 \quad}^\circ$$

22

$$f(x) = 3x \quad \text{and} \quad g(x) = x^2$$

Circle the expression for $fg(x)$

[1 mark]

$$3x^2$$

$$9x^2$$

$$3x^3$$

$$9x^4$$

Substituting $g(x)$ for x in $f(x)$. x is replaced with x^2



23

Here are two simultaneous equations.

$$y = x^2 + 7x - c$$

and

$$y = 3x + d$$

There is a solution when $x = 5$ Work out the value of $c + d$ **[3 marks]**

$$5^2 + 7 \times 5 - c = 3 \times 5 + d$$

$x^2 + 7x - c = 3x + d$ as both halves of the equation are equal to y . Substituting x for 5 as $x = 5$

$$5^2 + 7 \times 5 - 3 \times 5 = c + d$$

Rearranging to make $c + d$ the subject by adding c to both sides and subtracting 3×5 from both sides

Answer 45

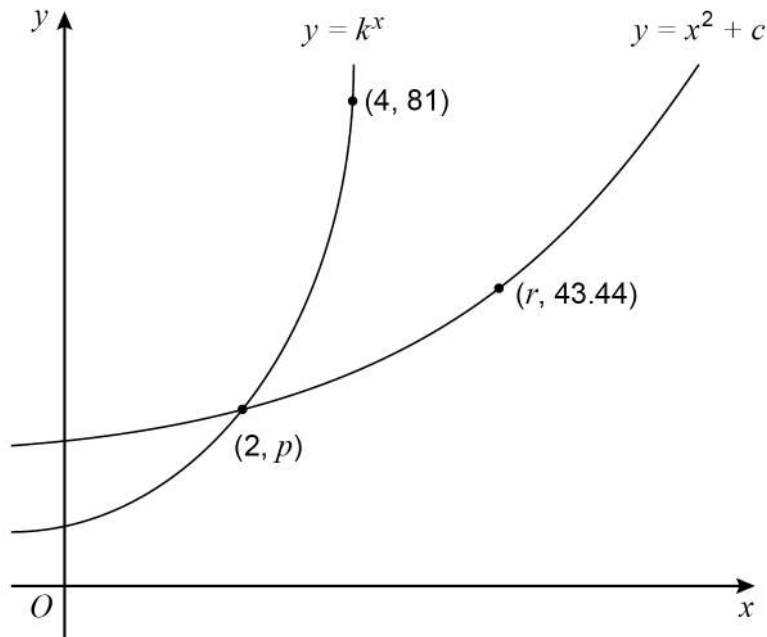
Turn over for the next question

Turn over ►



24

Here is a sketch of the graphs of $y = k^x$ and $y = x^2 + c$
 k and c are positive constants.



Work out the value of r .

[4 marks]

r cannot be found yet as c is unknown in the equation $y = x^2 + c$. c cannot be found yet as p is unknown. p cannot be found yet as k is unknown. k can be found

$$k = \sqrt[x]{y} = \sqrt[4]{81}$$

Rearranged the equation $y = k^x$ to make k the subject then substituted in the x and y -coordinate from $(4, 81)$

$$p = 3^2 = 3^2$$

Substituted in the value of k and the x -coordinate from $(2, p)$ to find p

$$c = y - x^2 \\ = 9 - 2^2$$

Rearranged the equation $y = x^2 + c$ to make c the subject then substituted in the x and y -coordinate from $(2, p)$ to find c

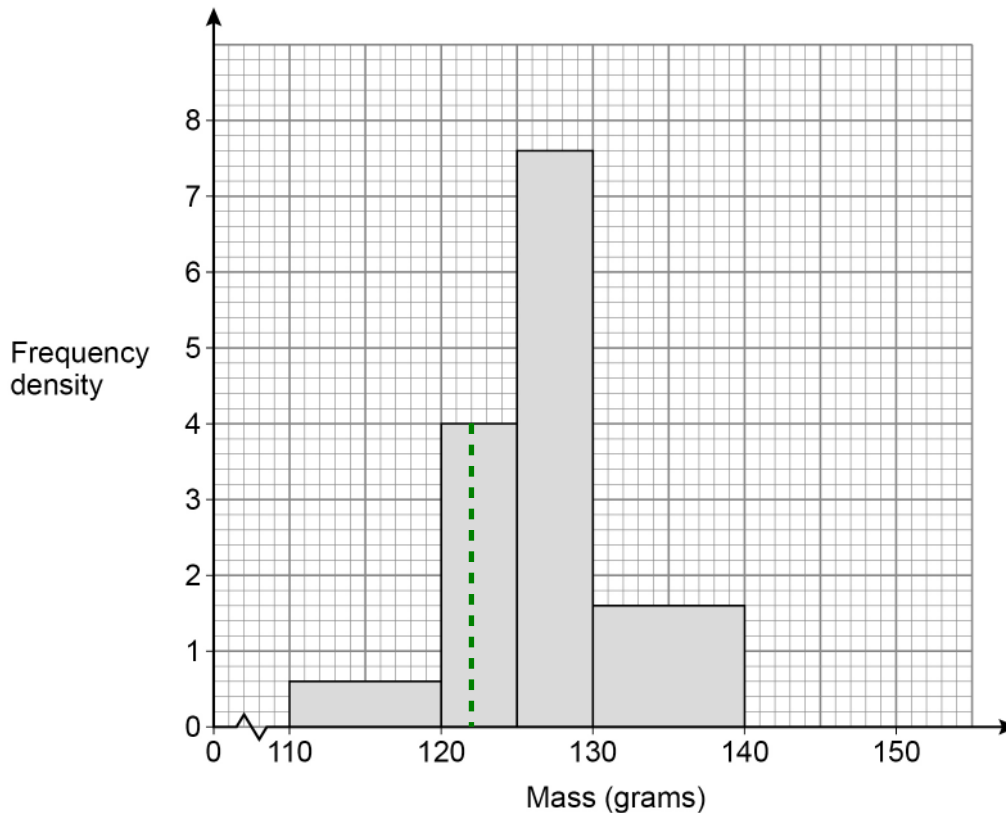
$$x = \sqrt{y - c} \\ = \sqrt{43.44 - 5}$$

Rearranged the equation $y = x^2 + c$ to make x the subject then substituted in the y -coordinate from $(r, 43.44)$ and the value of c to find r

$$r = \underline{\hspace{10em} 6.2 \hspace{10em}}$$



- 25 A company makes tubes of toothpaste.
The masses of 80 tubes are checked.
A histogram is drawn to represent the data.



The company makes 28 000 tubes each day.

Estimate how many tubes each day have a mass **less than** 122 grams.

[4 marks]

$$10 \times 0.6 = 6$$

$$2 \times 4 = 8$$

Frequency is the area of each box on a histogram. Multiplying the class width by the frequency density works out the frequency of the first bar and an estimate of the second bar up to 122g

$$6 + 8$$

Adding the frequency of the first bar and the estimate of the frequency of the second bar up to 122g works out that an estimated 14 tubes in the sample were less than 122 grams

$$\frac{14}{80} \times 28000$$

14 out of the 80 tubes in the sample are estimated to have mass less than 122 grams. Expressing this as a fraction and doing this fraction of the 28000 tubes as it can be estimated that the same fraction of tubes will be less than 122 grams in all the tubes

Answer _____

4900



26 Q and R are two numbers.

As a product of prime factors,

$$Q = 2^3 \times 3 \times a^3$$

$$R = 2^4 \times 3^2 \times a^2$$

26 (a) The highest common factor (HCF) of Q and R is 4056

Work out the value of a .

$$2^3 \times 3 \times a^2 = 4056$$

The HCF is the lowest power of each prime in both lists multiplied together

[2 marks]

$$a = \sqrt{\frac{4056}{2^3 \times 3}}$$

Rearranged to find a by dividing both sides by $2^3 \times 3$ then square rooting both sides

$$a = \underline{\hspace{10em} 13 \hspace{10em}}$$

26 (b) Work out the lowest common multiple (LCM) of Q and R .

$$2^4 \times 3^2 \times 13^3$$

The LCM is the highest power of each prime in both lists multiplied together

[2 marks]

$$\text{Answer } \underline{\hspace{10em} 316368 \hspace{10em}}$$



27 Expand and simplify fully $(x - 3)(x - 4)(x + 8)$

[3 marks]

$$x^2 - 4x - 3x + 12$$

Expanding the first two brackets

$$(x^2 - 7x + 12)(x + 8)$$

Simplifying by collecting like terms and writing multiplied by the third bracket

$$x^3 + 8x^2 - 7x^2 - 56x + 12x + 96$$

Expanding with the third bracket

Simplifying by collecting like terms

Answer _____ $x^3 + x^2 - 44x + 96$

END OF QUESTIONS

