

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

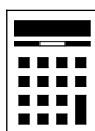
Paper 3 Calculator

Time allowed: 1 hour 30 minutes

Materials

For this paper you must have:

- a calculator
- mathematical instruments.



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	
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 b is 3 more than the square root of a .

Circle the correct equation.

[1 mark]

$$b = \sqrt{a} + 3$$

$$b = \sqrt{a} - 3$$

$$b = \sqrt{a+3}$$

$$b = \sqrt{a-3}$$

- 2 Circle the largest number.

[1 mark]

$$0.\dot{5}$$

$$0.55$$

$$0.545$$

$$0.5\dot{4}5$$

$$0.555\dots$$

$$0.550$$

$$0.545$$

$$0.545\dots$$

Writing the numbers to 3 decimal places is enough for the largest to be identified

- 3 A line has equation $3y = 3x - 2$

Circle the coordinates of the intercept of the line with the y -axis.

[1 mark]

$$(0, 1)$$

$$(0, -1)$$

$$\left(0, \frac{2}{3}\right)$$

$$\left(0, -\frac{2}{3}\right)$$

Dividing both sides of the equation by 3 brings it into the form $y = mx + c$, where m is the gradient and c is the y intercept. c would be $-2/3$. The x coordinate must be 0 as it is a point on the y axis



- 4 Factorise $x^2 - 64$
Circle your answer.

[1 mark]

$(x + 8)^2$

$(x - 8)^2$

$(x + 8)(x - 8)$

$x(x - 64)$

Difference of two squares can be used here. $a^2 - b^2 = (a + b)(a - b)$

- 5 Six positive numbers have
a mean of 10
a range of 19

Four of the numbers are 12 7 15 3

Work out the other two numbers.

[3 marks]

$$6 \times 10 - 12 - 7 - 15 - 3 = 23$$

$$x + x + 19 = 23$$

$$x = \frac{23 - 19}{2}$$

Answer 2 and 21

Mean = total/number so total = mean x number. 6×10 works out the total of all six of the numbers. Subtracting the four numbers leaves the total of the other two numbers. The other two numbers need to add up to 23. Assuming 3 is the smallest number, adding the range of 19 gives the largest number which would be 22, meaning that one of the two numbers would be 22 and the other would have to be 1, which is not possible as 3 was assumed to be the smallest. So one of the other two numbers must be smaller than 3. Let x be the smallest number. The largest number would be $x + 19$. Adding x and $x + 19$ must give 23. Rearranging to solve x gives the smallest number which must be 2. Then adding 19 gives the largest number which must be 21

Turn over ►



- 6 At a country park there is a house, a museum and a garden.
The table shows the prices per person to visit the park.

	Price per person
Garden only	Free
House and museum	£12.50
House only	£8
Museum only	£7

One day, 480 people visit the park.

67 visit the garden **only**.

40% visit the house **and** the museum.

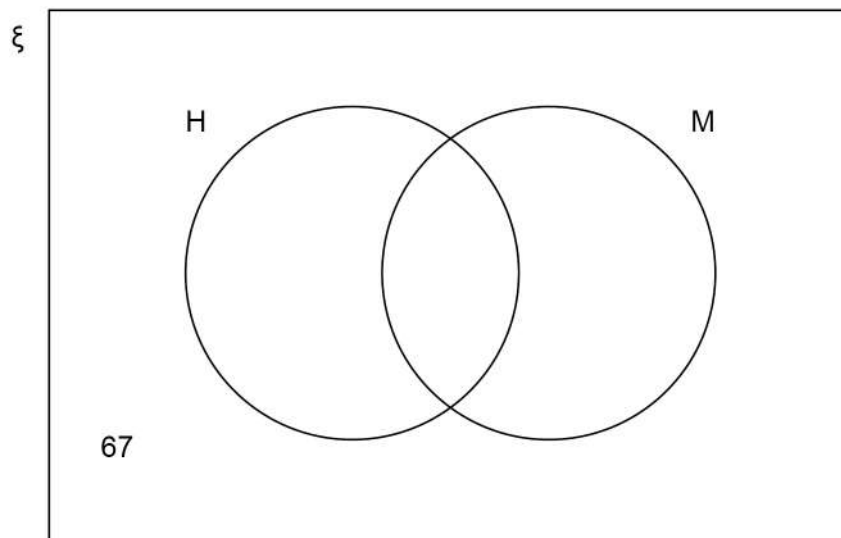
$\frac{3}{8}$ visit the house **only**.

The rest visit the museum **only**.

In total, how much do the 480 people pay to visit the park?

You may use the Venn diagram to help you.

[5 marks]



$$\frac{40}{100} \times 480 = 192$$

The number of people who visited the house and the museum

$$\frac{3}{8} \times 480 = 180$$

The number of people who visited the house only

$$480 - 192 - 180 - 67 = 41$$

Subtracting the number of people who visited the house and the museum, the house only and the garden only leaves the number who visited the museum only

$$192 \times 12.50 + 180 \times 8 + 41 \times 7$$

Adding together the amounts paid to visit the house and the museum, the house only and the museum only gives the total amount paid. The garden is ignored as it is free

The amount paid to visit the house and the museum

The amount paid to visit the house only

The amount paid to visit the museum only

Answer £

4127

7

Jeff and Kaz share £270 in the ratio Jeff : Kaz = 2.6 : 1

How much **more** than Kaz does Jeff get?

[3 marks]

$$\frac{270}{2.6+1} \times (2.6-1)$$

2.6 + 1 works out how many parts there are in total in the ratio. Dividing the £270 by this works out what 1 part is worth. 2.6 - 1 works out how many parts Jeff gets more than Kaz. Multiplying this many parts by the worth of 1 part gives how much more than Kaz Jeff gets

Answer £

120

8

Turn over ►



8 The heel of a shoe exerts a pressure of 198 pounds per square inch.

Convert this pressure into kilograms per square centimetre.

Use

1 pound = 0.45 kilograms

1 square inch = 6.25 square centimetres

[3 marks]

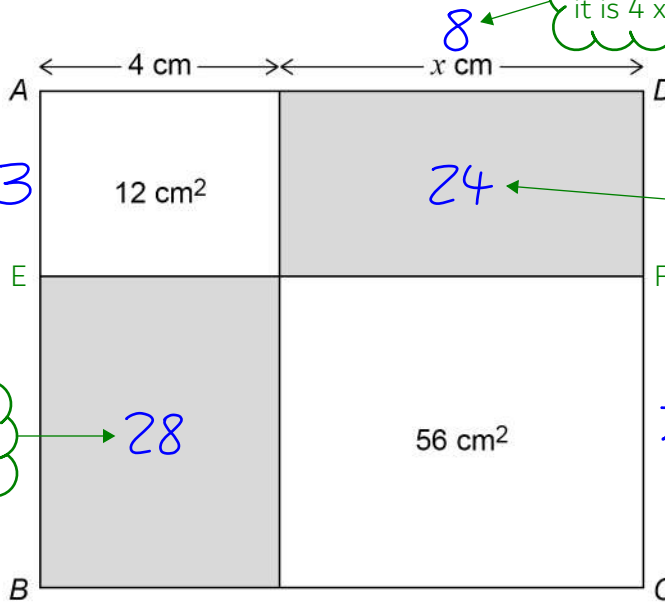
$$\frac{198 \times 0.45}{6.25}$$

198 x 0.45 converts the pounds into kilograms. Dividing this by 6.25 as it is per square centimetre. Per means to divide and there are 6.25 square centimetres in 1 square inch

Answer 14.256 kg/cm²



9 Rectangle $ABCD$ is split into four smaller rectangles.
Two of the smaller rectangles are shaded.



$4 : x = 1 : 2$

For rectangle $ABCD$, work out the ratio shaded area : unshaded area
Give your answer in its simplest form.

[4 marks]

Area of rectangle = length x width

Ratios simplify in a similar way to fractions so putting the total shaded area over the total unshaded area

$(24 + 28) / (12 + 56) = 13/17$

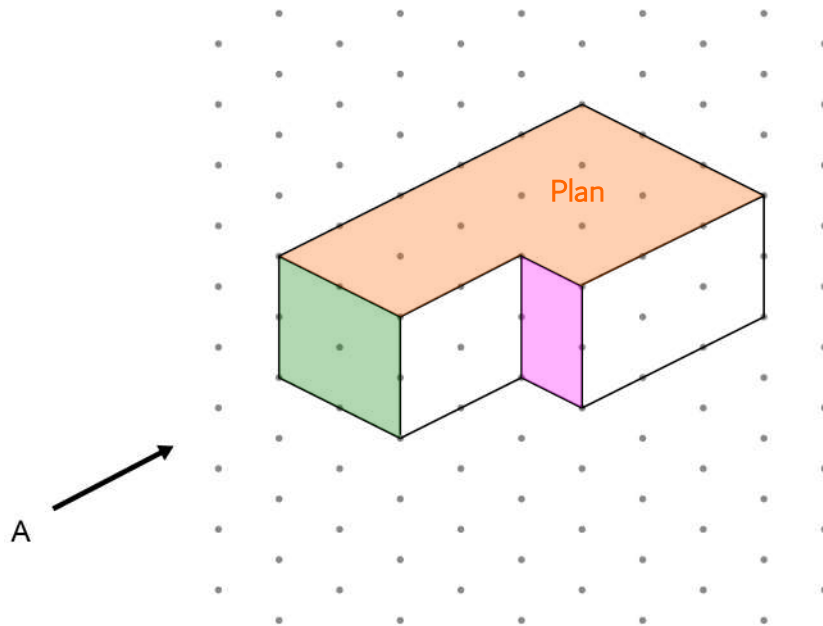
Answer 13 : 17

7

Turn over ►

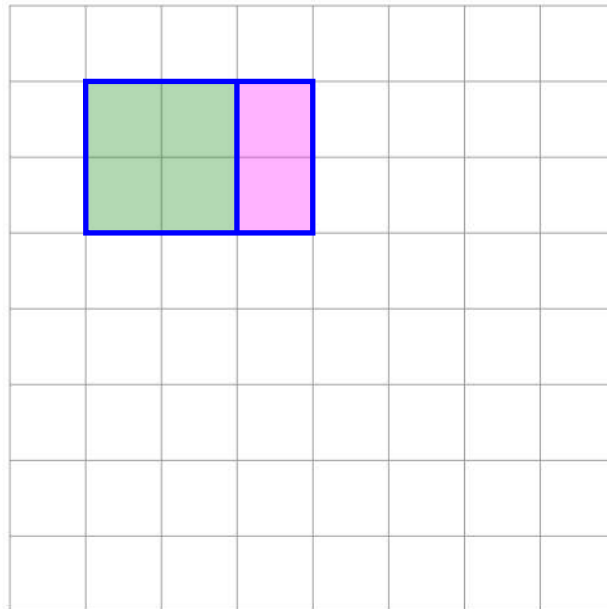


- 10 A solid shape is drawn on isometric paper.



- 10 (a) On the centimetre grid, draw the elevation of the shape from A.

[1 mark]

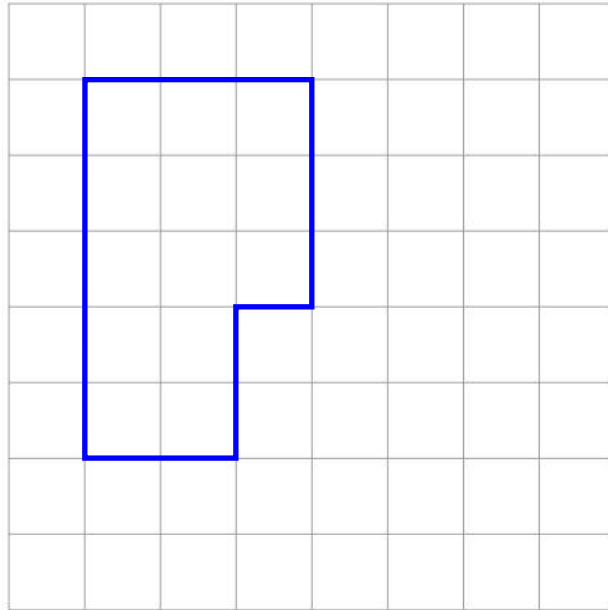


The shading is only to illustrate the faces seen and is not needed as part of the answer



- 10 (b) On the centimetre grid, draw a plan of the shape.

[1 mark]



- 11 Erik thinks of a prime number between 20 and 30

His number is $x\%$ of 125

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

[3 marks]

$$\frac{23}{125} \times 100$$

23 is prime as it only has two factors, itself and 1.
Writing 23 as a fraction of 125 then multiplying
by 100 to convert it into a percentage

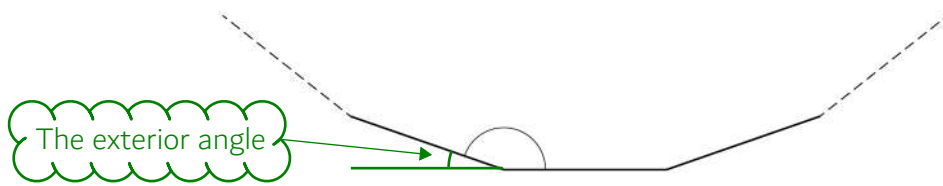
Answer 18.4

5

Turn over ►



12 Part of a regular polygon with 15 sides is shown.



Not drawn
accurately

Work out the size of an **interior** angle.

[2 marks]

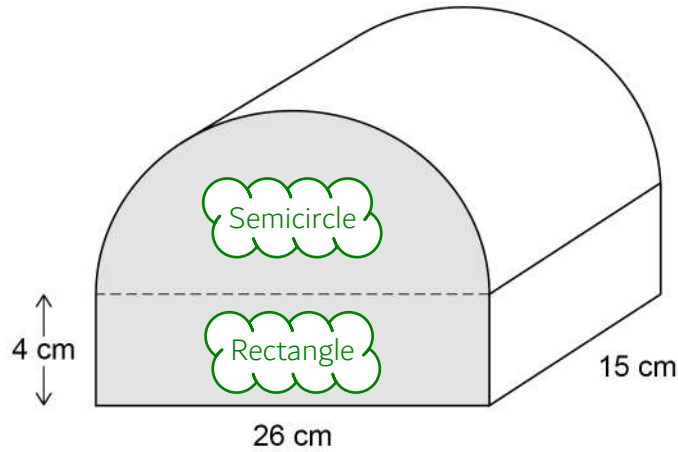
$$180 - \frac{360}{15}$$

All of the exterior angles on a polygon add up to 360° . As it has 15 sides it must have 15 exterior angles. So $360/15$ works out the exterior angle. The exterior angle and the interior angle lie around a point on a straight line and angles around a point on a straight line add up to 180° . So subtracting the exterior angle from 180 works out the interior angle

Answer 156 degrees



13 A box is the shape of half a cylinder on top of a cuboid.



Work out the volume of the box.

[4 marks]

$$15(26 \times 4 + \frac{1}{2} \pi \times (\frac{26}{2})^2)$$

Volume of prism = cross sectional area x length. The box is similar to a prism. Adding the area of the rectangle and the semicircle gives the cross sectional area. Multiplying this by 15 as this is the length

Area of rectangle = length x width. The length of the rectangle is 26cm and the width is 4cm

Area of circle = πr^2 , where r is the radius. The radius is 26/2. Multiplying this by 1/2 as it is a semicircle

Answer 5542.0 cm³



14

Phil sells ties.

He increases the original price of each tie by 10% to £13.20

A month later he announces a sale.



Phil says,

“The ties will be back to their original price, because each change was by 10%”

Is he correct?

Tick a box.

Yes

No

Show working to support your answer.

[3 marks]

$$x \times \frac{100+10}{100} \times \frac{100-10}{100}$$

Let x be the original price. To increase by 10%: 100 + 10 works out the percentage it increases to then dividing by 100 converts it into a fraction which when multiplied by will increase by 10%. To decrease by 10%: 100 - 10 works out the percentage it decreases to then dividing by 100 converts it into a fraction which when multiplied by will decrease by 10%

$$0.99x$$

x was the original price and this is not x so the ties will not be back to their original price



15

A biased spinner can land on A, B or C.

The table shows the probabilities, in terms of k , of A, B and C.

	A	B	C
Probability	$0.5k$	$7k - 0.15$	$2.5k$

Work out the probability of B.

[3 marks]

$$0.5k + 7k - 0.15 + 2.5k = 1$$

It is certain to be either A, B or C therefore the probabilities of them all added together must equal 1

$$10k = 1.15$$

Collecting the k terms and adding 0.15 to both sides to get the k terms on their own

$$k = 0.115$$

Dividing both sides by 10 finds k

$$7(0.115) - 0.15$$

Substituting k for 0.115 in the expression for the probability of B

Answer

0.655

Turn over for the next question



16

 P is the point (2, 14) Q is the point (6, 8) R is the point (2, 5)Use gradients to show that angle PQR is **not** a right angle.**[3 marks]**

$$\frac{8-14}{6-2} \times \frac{5-8}{2-6} \neq -1$$

Perpendicular gradients multiply to -1. As they don't the angle cannot be a right angle

Gradient
of PQ

Gradient
of QR

Gradient = (change in y)/(change in x).
Change in y is found by subtracting the first y coordinate from the second y coordinate.
Change in x is found by subtracting the first x coordinate from the second x coordinate



17 $m^2 > 9$

Circle the possible value of m .

[1 mark]

$-2\frac{7}{8}$

2.8

3

$\frac{7}{2}$

$(-2\frac{7}{8})^2 = 8.2\dots$ which is not greater than 9.
 $2.8^2 = 7.84$ which is not greater than 9.
 $3^2 = 9$ which is not greater than 9.
 $(-7/2)^2 = 12.25$ which is greater than 9

18 Simplify $w^1 \times w^0$

Circle your answer.

[1 mark]

1

0

 w w^2

$a^x \times a^y = a^{x+y}$. So $w^1 \times w^0 = w^{1+0} = w^1 = w$

19 The equation of a circle is $x^2 + y^2 = 11$

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

Circle your answer.

[1 mark]

$\sqrt{11}$

$2\sqrt{11}$

$\sqrt{22}$

22

The general equation of a circle with its centre at $(0, 0)$ is $x^2 + y^2 = r^2$, where r is the radius. $r^2 = 11$ so the radius is $\sqrt{11}$. The diameter is double the radius

Turn over for the next question

Turn over ►



20

$$\frac{a}{b} = 3c$$

$$\frac{b}{c} = 2$$

Work out the value of a when $c = 8$

[3 marks]

$$a = 3bc$$

Rearranging to make a the subject in the first equation by multiplying both sides by b

$$b = 2c$$

Rearranging to make b the subject in the second equation by multiplying both sides by c

$$3 \times 2 \times 8 \times 8$$

Substituting b for $2c$ in $a = 3bc$ and then c for 8 in the right side

Answer

384

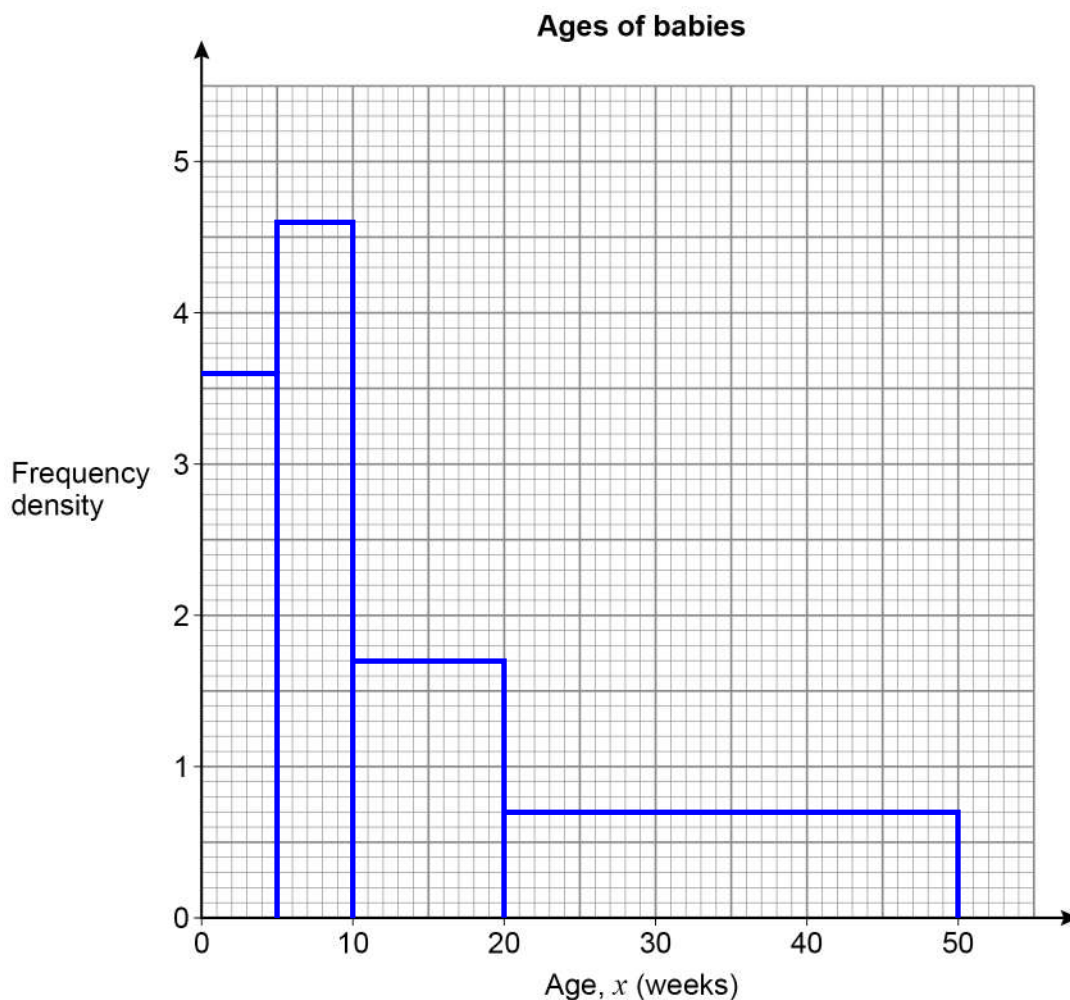


21

Here is some information about the ages of babies at a clinic.

Age, x (weeks)	Frequency		
$0 \leq x < 5$	18		
$5 \leq x < 10$	23		
$10 \leq x < 20$	17		
$20 \leq x < 50$	21		

Draw a histogram to represent the information.

[4 marks]

Frequency is the area of each box on the histogram so
frequency = frequency density \times class width.
Frequency density = frequency / (class width). Class width is
the upper bound subtract the lower bound for each interval

$$\begin{aligned} 18 / (5 - 0) &= 3.6 \\ 23 / (10 - 5) &= 4.6 \\ 17 / (20 - 10) &= 1.7 \\ 21 / (50 - 20) &= 0.7 \end{aligned}$$

Turn over ►



22

A sequence of patterns is made using horizontal sticks and vertical sticks.

Pattern 1



Pattern 2



Pattern 3



The table shows the number of horizontal sticks and vertical sticks in each pattern.

Pattern	Number of horizontal sticks	Number of vertical sticks
1	2	2
2	4	3
3	6	4

What fraction of the total number of sticks in Pattern n are horizontal?

Give your answer in terms of n .

[3 marks]

Expressing the n th term for the horizontal sticks as a fraction of the n th term for the total number of sticks gives the desired fraction. The number of horizontal sticks increases by 2 between each term so must involve $2n$. The 0th term, the term before the first term, in the sequence 2, 4, 6 would be 0 so the n th term of the horizontal sticks is $2n + 0$, or just $2n$. The number of vertical sticks increases by 1 between each term so must involve n . The 0th term, the term before the first term, in the sequence 2, 3, 4 would be 1 so the n th term of the vertical sticks is $n + 1$. Adding the n th term of the horizontal and vertical sticks gives the n th term of the total number of sticks

Answer $\frac{2n}{2n+n+1}$



23 The equation of a curve is $y = 16^x$

23 (a) Circle the point that lies on the curve.

[1 mark]

(2, 32)

(32, 2)

(2, 256)

(256, 2)

The y coordinate must be equal to 16 to the power of the x coordinate. $16^2 = 256$

23 (b) A different point on the curve has y-coordinate $\frac{1}{16}$

Work out the x-coordinate.

[1 mark]

The power of -1 does the reciprocal, which means 1 over the number

Answer

-1

24 $a^b = 3$ where a is an integer and b is a proper fraction.

Work out **one** possible pair of values of a and b .

[1 mark]

The power of $1/2$ means to do the positive square root. The positive square root of 9 is 3

$a = 9$ $b = \frac{1}{2}$



25

Expand and simplify fully $(x-3)(x+2)(x+5)$ **[3 marks]**

$$x^2 + 2x - 3x - 6$$

Expanding the first two brackets

$$(x^2 - x - 6)(x + 5)$$

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

$$x^3 + 5x^2 - x^2 - 5x - 6x - 30$$

Expanding these two brackets

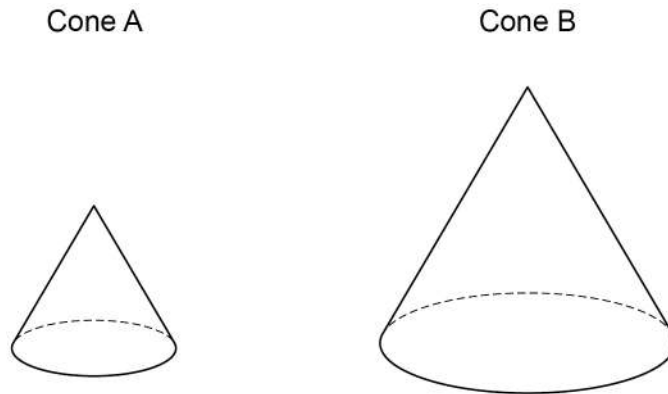
Simplifying by collecting like terms

Answer $x^3 + 4x^2 - 11x - 30$



26

Here are two similar cones.

The surface area of cone A is 2 m^2 The surface area of cone B is 4.5 m^2

Work out the ratio radius of cone A : radius of cone B

Give your answer in the form $1 : n$ **[3 marks]**

$$\sqrt{2} : \sqrt{4.5}$$

The ratio of the areas is $2 : 4.5$. Square rooting both sides gives the ratio of the lengths. As the radius is a length this is the ratio we are looking for

Dividing both sides of the ratio
by $\sqrt{2}$ to get 1 part on the left

Answer 1 : 1.5



27

In the diagram

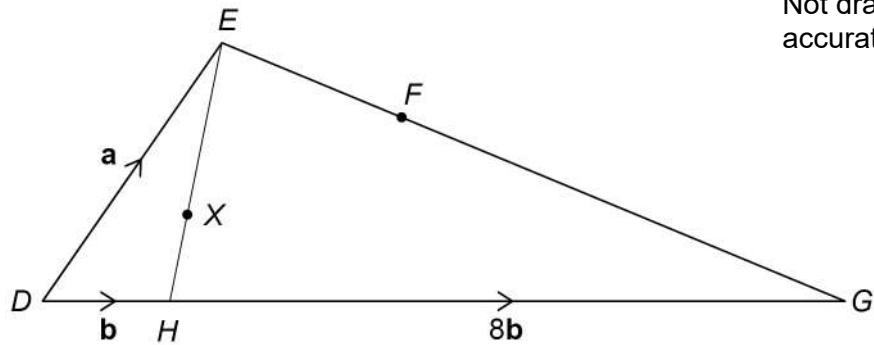
$$\overrightarrow{DE} = \mathbf{a}$$

$$\overrightarrow{DH} = \mathbf{b}$$

$$\overrightarrow{HG} = 8\mathbf{b}$$

$$EX : XH = 3 : 1$$

$$EF : FG = 1 : 3$$

Not drawn
accurately

27 (a) Show that $\overrightarrow{DX} = \frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}$

[2 marks]

$$b + \frac{1}{4}(-b + a)$$

$$\frac{1}{4}a + \frac{3}{4}b$$

$\overrightarrow{DX} = \overrightarrow{DH} + \overrightarrow{HX}$. $\overrightarrow{DH} = \mathbf{b}$. $\overrightarrow{HX} = \frac{1}{4}\overrightarrow{HE}$ as 1 out of the 4 parts going from EH is XH in the ratio EX : XH. $\overrightarrow{HE} = \overrightarrow{HD} + \overrightarrow{DE}$. $\overrightarrow{HD} = -\mathbf{b}$ as it is going the opposite direction to \overrightarrow{DH} . $\overrightarrow{DE} = \mathbf{a}$



27 (b) Is DXF a straight line?

Show working to support your answer.

[4 marks]

$$a + \frac{1}{4}(-a + 9b)$$

$$\frac{3}{4}a + \frac{9}{4}b$$

$$3\left(\frac{1}{4}a + \frac{3}{4}b\right)$$

Yes

$\vec{DF} = \vec{DE} + \vec{EF}$. $\vec{DE} = a$. $\vec{EF} = \frac{1}{4}\vec{EG}$ as 1 out of the 4 parts going from EG is EF in the ratio EF : FG. $\vec{EG} = \vec{ED} + \vec{DG}$. $\vec{ED} = -a$ as it is going the opposite direction to \vec{DE} . $\vec{DG} = \vec{DH} + \vec{HG} = b + 8b$

\vec{DF} can be expressed as something multiplied by \vec{DX} and both vectors go from D therefore DXF must be a straight line

Turn over for the next question

Turn over ►



28

 $a = 4.72$ to 3 significant figures. $b = 158$ to 3 significant figures.Work out the upper bound of $\frac{a}{b}$ You **must** show your working.**[3 marks]**

$$\frac{4.72 + \frac{0.01}{2}}{158 - \frac{1}{2}}$$

The third significant figure in 4.72 has a resolution of 0.01. Adding half of this gives the upper bound for a. The third significant figure in 158 has a resolution of 1. Subtracting half of this gives the lower bound for b, which is needed as b is a denominator and should be as small as possible in order for a/b to be as great as possible

Answer 0.03



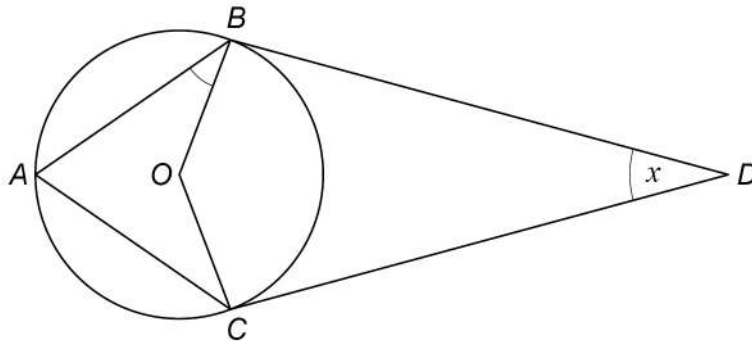
29

A , B and C are three points on the circumference of a circle, centre O .

BD and CD are tangents to the circle.

$ABDC$ is a kite.

Angle BDC is x



Not drawn
accurately

Prove that angle ABO is $45^\circ - \frac{x}{4}$

[4 marks]

Angles OBD and OCD are 90° as the angle between a tangent and radius is a right angle.

$360 - 90 - 90 - x = 180 - x = \text{BOC obtuse}$ as angles in a quadrilateral add up to 360° .

Subtracting angles OBD , OCD and BDC in quadrilateral $OBDC$

$BAC = 90 - x/2$ as angles at the circumference are half the angle at the centre.

$ABD + ACD = 360 - x - (90 - x/2) = 270 - x/2$ as angles in a quadrilateral add up to 360° .

Subtracting angles BDC and BAC in quadrilateral $ABDC$

$ABD = 135 - x/4$ as two of the angles in a kite are equal so ABD is $1/2$ of $ABD + ACD$.

$ABD = ACD$

$ABO = 135 - x/4 - 90 = 45 - x/4$

Subtracting OBD from ABD



- 30** A sphere has radius r cm
An approximate value of r can be found using the iterative formula

$$r_{n+1} = \sqrt{\frac{239}{r_n}}$$

The starting value is $r_1 = 7$

- 30 (a)** Work out the values of r_2 and r_3

[2 marks]

Enter 7 then press =. Enter $\sqrt{239/ANS}$ then
press = to get r_2 . Press = again to get r_3

$$r_2 = 5.84$$

$$r_3 = 6.40$$

- 30 (b)** Continue the iteration to work out the radius to 1 decimal place.

[1 mark]

Keep pressing = until the 2nd
decimal place stops changing

Answer 6.2 cm

END OF QUESTIONS

