

Please write clearly in block capitals.

Centre number

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Candidate number

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Surname StemUp Model Solution

Forename(s) _____

Candidate signature _____

I declare this is my own work.

GCSE MATHEMATICS

H

Higher Tier

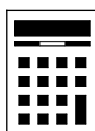
Paper 3 Calculator

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.

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	
22–23	
24–25	
26	
TOTAL	



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

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]

$$0.\dot{5}$$

$$0.55$$

$$0.545$$

$$0.5\dot{4}\dot{5}$$

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

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

[1 mark]

$$(0, 1)$$

$$(0, -1)$$

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

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



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

[1 mark]

$(x + 8)^2$

$(x - 8)^2$

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

$x(x - 64)$

- 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]

$$\text{Total} = 6 \times 10 = 60$$

$$12 + 7 + 15 + 3 = 37$$

$$\text{The other two numbers add up to } 60 - 37 = 23$$

$$\text{Range 19: smallest} = a, \text{ largest} = a + 19$$

$$a + a + 19 = 23 \rightarrow 2a = 4 \rightarrow a = 2, \text{ largest} = 21$$

$$\text{Check: } 2, 3, 7, 12, 15, 21 \text{ has range } 21 - 2 = 19$$

Answer 2 and 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.

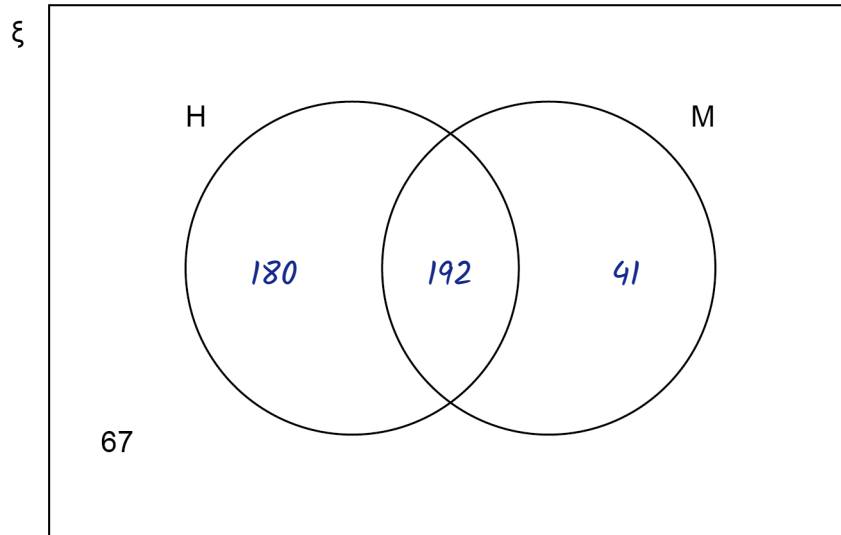
$\frac{3}{8}$ visit the house **only**.

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]



$$\text{House and museum} = 40\% \text{ of } 480 = 0.4 \times 480 = 192$$

$$\text{House only} = \frac{3}{8} \times 480 = 180$$

$$\text{Museum only} = 480 - 67 - 192 - 180 = 41$$

$$\text{House and museum: } 192 \times £12.50 = £2400$$

$$\text{House only: } 180 \times £8 = £1440$$

$$\text{Museum only: } 41 \times £7 = £287$$

$$\text{Garden only: } 67 \times £0 = £0$$

$$\text{Total} = 2400 + 1440 + 287 = £4127$$

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]

$$\text{Total parts} = 2.6 + 1 = 3.6$$

$$\text{One part} = 270 \div 3.6 = £75 \text{ (Kaz)}$$

$$\text{Jeff} = 75 \times 2.6 = £195$$

$$\text{Difference} = 195 - 75 = £120$$

Answer £ 120

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

$$1 \text{ pound} = 0.45 \text{ kilograms}$$

$$1 \text{ square inch} = 6.25 \text{ square centimetres}$$

[3 marks]

$$198 \text{ pounds} = 198 \times 0.45 = 89.1 \text{ kg}$$

so the pressure is 89.1 kg per square inch

$$1 \text{ square inch} = 6.25 \text{ cm}^2$$

$$89.1 \div 6.25 = 14.256 \text{ kg/cm}^2$$

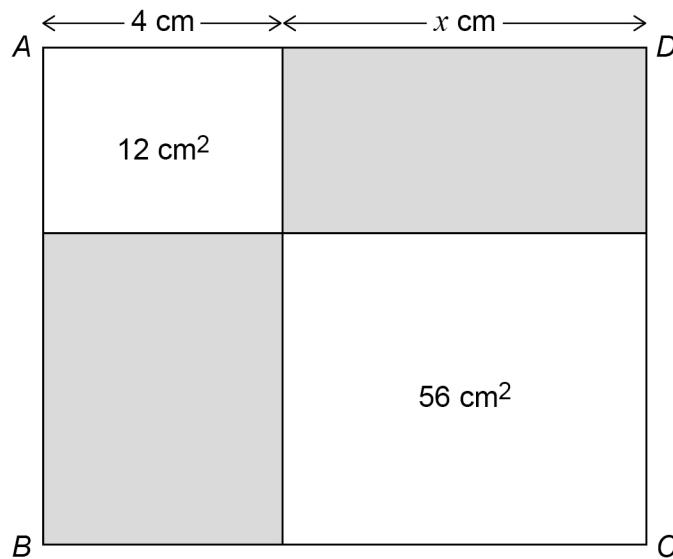
Answer 14.256 kg/cm²



9

Rectangle $ABCD$ is split into four smaller rectangles.

Two of the smaller rectangles are shaded.



Not drawn
accurately

$$4 : x = 1 : 2$$

For rectangle $ABCD$, work out the ratio shaded area : unshaded area

Give your answer in its simplest form.

[4 marks]

$$4 : x = 1 : 2 \text{ so } x = 4 \times 2 = 8$$

$$\text{Height of top rectangles} = 12 \div 4 = 3 \text{ cm}$$

$$\text{Height of bottom rectangles} = 56 \div 8 = 7 \text{ cm}$$

$$\text{Shaded top right} = 8 \times 3 = 24 \text{ cm}^2$$

$$\text{Shaded bottom left} = 4 \times 7 = 28 \text{ cm}^2$$

$$\text{Shaded} = 24 + 28 = 52 \text{ cm}^2$$

$$\text{Unshaded} = 12 + 56 = 68 \text{ cm}^2$$

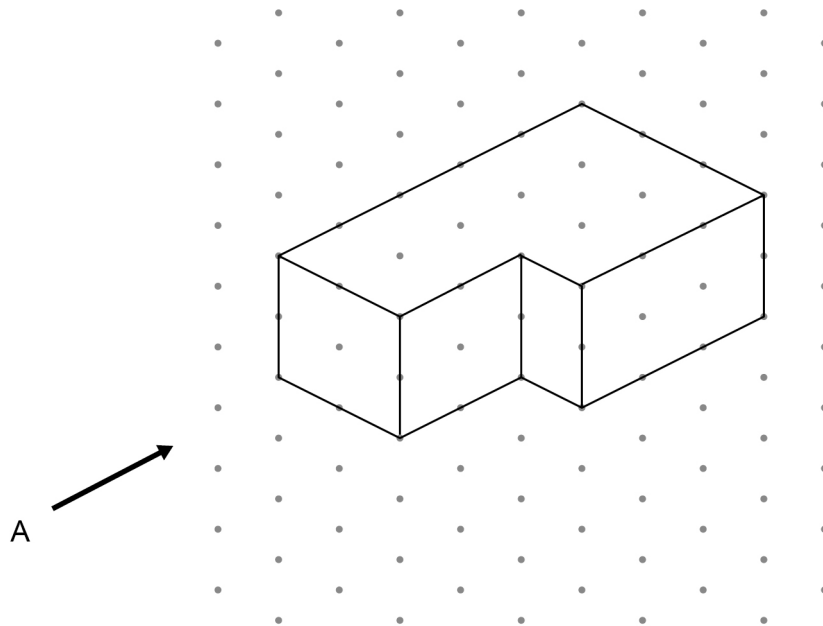
$$\text{Shaded : unshaded} = 52 : 68 = 13 : 17 \text{ } (\div 4)$$

Answer 13 : 17

Turn over ►

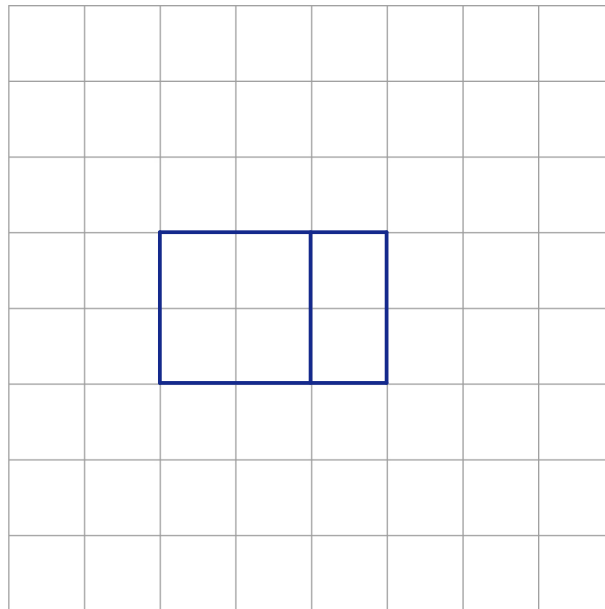


- 10** A solid shape is drawn on isometric paper.



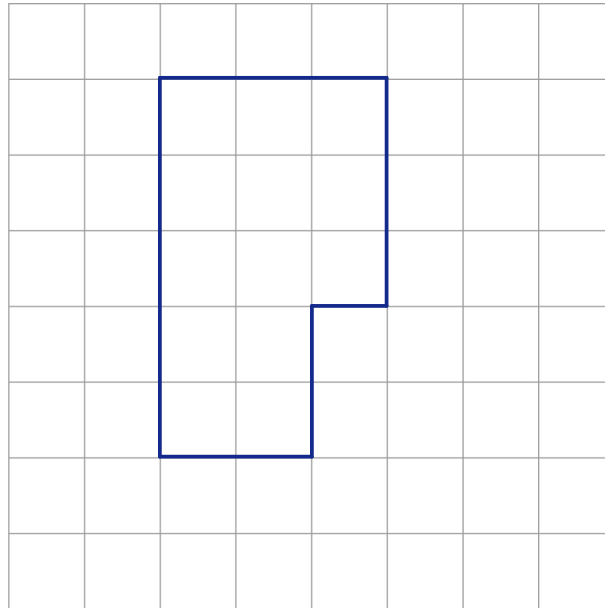
- 10 (a)** On the centimetre grid, draw the elevation of the shape from A.

[1 mark]



- 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]

Prime numbers between 20 and 30: 23 and 29

Use 23

$$x = 23 \div 125 \times 100 = 18.4$$

$$\text{Check: } 18.4\% \text{ of } 125 = 0.184 \times 125 = 23$$

Answer 18.4

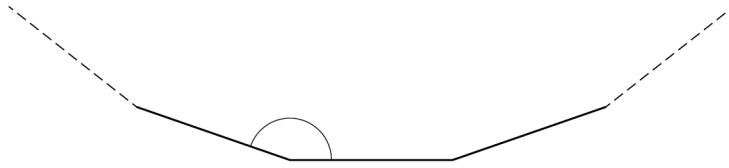
5

Turn over ►



12

Part of a regular polygon with 15 sides is shown.

Not drawn
accuratelyWork out the size of an **interior** angle.**[2 marks]**

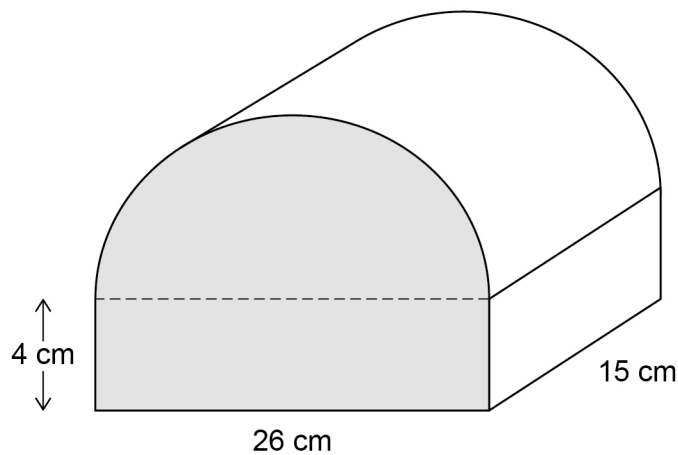
$$\text{Exterior angle} = 360^\circ \div 15 = 24^\circ$$

$$\text{Interior angle} = 180^\circ - 24^\circ = 156^\circ$$

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]

$$\text{Cuboid} = 26 \times 4 \times 15 = 1560 \text{ cm}^3$$

$$\text{Radius of half cylinder} = 26 \div 2 = 13 \text{ cm}$$

$$\text{Half cylinder} = \frac{1}{2} \times \pi \times 13^2 \times 15$$

$$= 1267.5\pi = 3981.968688... \text{ cm}^3$$

$$\text{Total volume} = 1560 + 3981.968688...$$

$$= 5541.968688...$$

$$= 5541.97 \text{ cm}^3 \text{ (2 dp)}$$

Answer 5541.97 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]

$$\text{Original price} = 13.20 \div 1.1 = £12$$

$$\text{Sale price} = 13.20 \times 0.9 = £11.88$$

$£11.88 \neq £12$, so the ties are not back to the original price.

No: the 10% off is 10% of £13.20 (£1.32), which is more than the 10% increase on £12 (£1.20).



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]

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

$$10k - 0.15 = 1$$

$$10k = 1.15$$

$$k = 0.115$$

$$P(B) = 7 \times 0.115 - 0.15$$

$$= 0.805 - 0.15 = 0.655$$

Answer 0.655

Turn over for the next question

Turn over ►



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]**

$$\text{Gradient of } PQ = \frac{8 - 14}{6 - 2} = \frac{-6}{4} = -1.5$$

$$\text{Gradient of } QR = \frac{5 - 8}{2 - 6} = \frac{-3}{-4} = 0.75$$

If angle PQR were 90° , the product of the gradients would be -1

$$-1.5 \times 0.75 = -1.125$$

$-1.125 \neq -1$, so PQ and QR are not perpendicular.

So angle PQR is not a right angle.



17 $m^2 > 9$

Circle the possible value of m .

[1 mark]

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

2.8

3

$-\frac{7}{2}$

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

Circle your answer.

[1 mark]

1

0

w

w^2

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

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]**

$$\frac{b}{c} = 2 \text{ so } b = 2c = 2 \times 8 = 16$$

$$\frac{a}{b} = 3c \text{ so } \frac{a}{16} = 3 \times 8 = 24$$

$$a = 24 \times 16$$

$$a = 384$$

Answer 384

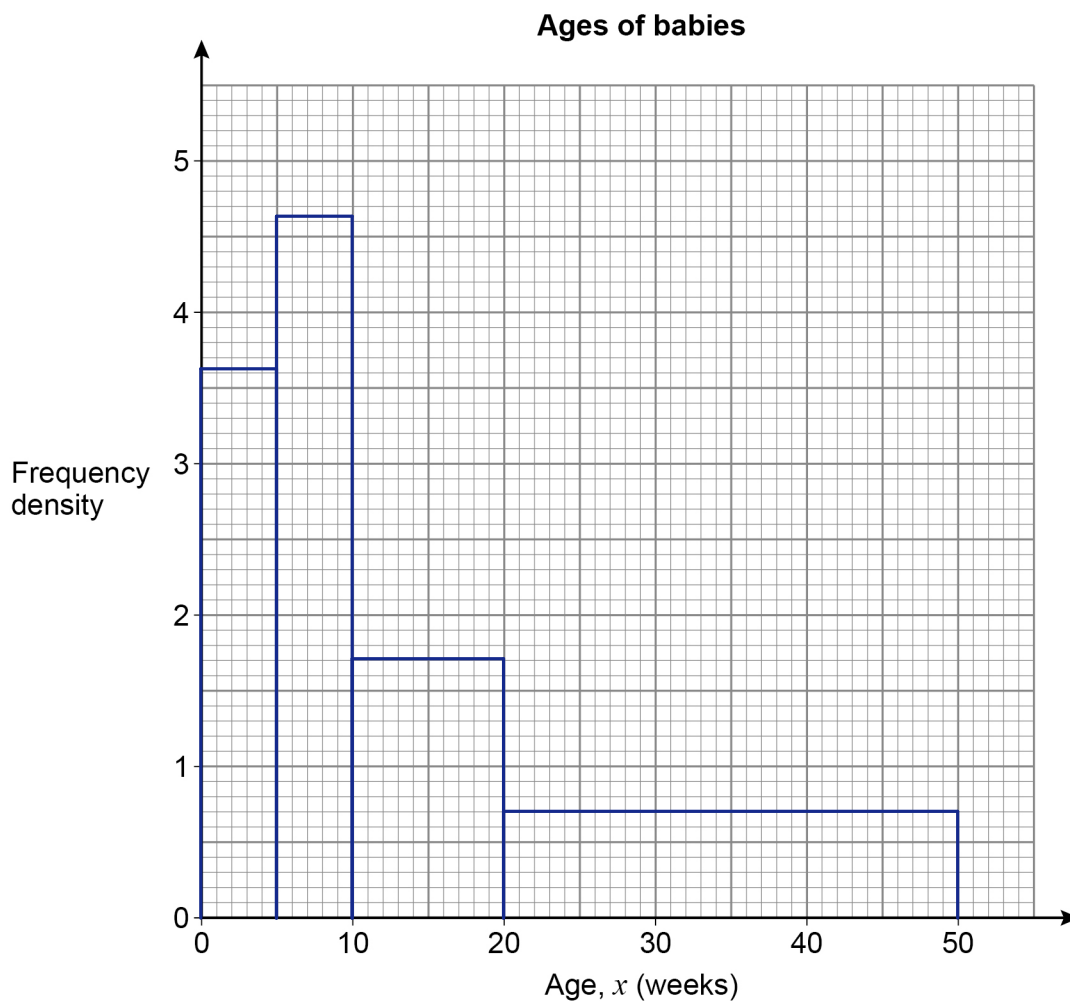
21

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

Age, x (weeks)	Frequency	Class width	Freq. density
$0 \leq x < 5$	18	5	$18 \div 5 = 3.6$
$5 \leq x < 10$	23	5	$23 \div 5 = 4.6$
$10 \leq x < 20$	17	10	$17 \div 10 = 1.7$
$20 \leq x < 50$	21	30	$21 \div 30 = 0.7$

Draw a histogram to represent the information.

[4 marks]



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]

Horizontal sticks: 2, 4, 6, ... $\rightarrow 2n$

Vertical sticks: 2, 3, 4, ... $\rightarrow n + 1$

Total sticks = $2n + n + 1 = 3n + 1$

Fraction horizontal = $\frac{2n}{3n + 1}$

Answer $\frac{2n}{3n + 1}$



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)

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

Work out the x -coordinate.

[1 mark]

$$16^x = \frac{1}{16} = 16^{-1} \text{ so } x = -1$$

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]

$$9^{1/2} = \sqrt{9} = 3$$

9 is an integer and 1/2 is a proper fraction

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



25 Expand and simplify fully $(x - 3)(x + 2)(x + 5)$

[3 marks]

$$(x - 3)(x + 2) = x^2 + 2x - 3x - 6$$

$$= x^2 - x - 6$$

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

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

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

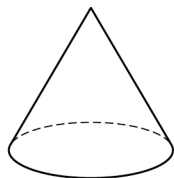
Answer $x^3 + 4x^2 - 11x - 30$



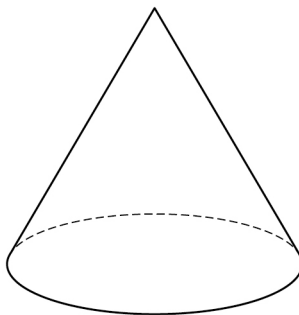
26

Here are two similar cones.

Cone A



Cone B

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]**

$$\text{Area scale factor} = 4.5 \div 2 = 2.25$$

$$\text{Length scale factor} = \sqrt{2.25} = 1.5$$

$$\text{radius of A : radius of B} = 1 : 1.5$$

Answer 1 : 1.5



27

In the diagram

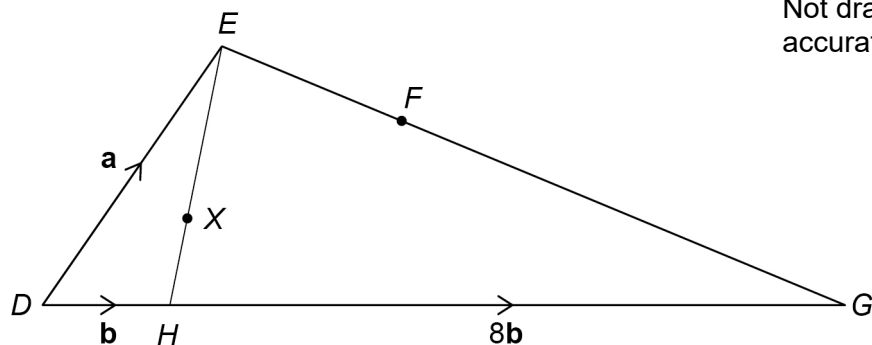
$$\overrightarrow{DE} = \mathbf{a}$$

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

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

$$EX : XH = 3 : 1$$

$$EF : FG = 1 : 3$$

Not drawn
accurately

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

[2 marks]

$$\overrightarrow{EH} = \overrightarrow{ED} + \overrightarrow{DH} = -\mathbf{a} + \mathbf{b}$$

$$\overrightarrow{EX} = \frac{3}{4}\overrightarrow{EH} = \frac{3}{4}(-\mathbf{a} + \mathbf{b}) \quad (EX : XH = 3 : 1)$$

$$\overrightarrow{DX} = \overrightarrow{DE} + \overrightarrow{EX}$$

$$= \mathbf{a} + \frac{3}{4}(-\mathbf{a} + \mathbf{b})$$

$$= \mathbf{a} - \frac{3}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}$$

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



27 (b) Is DXF a straight line?

Show working to support your answer.

[4 marks]

$$\overrightarrow{DG} = \overrightarrow{DH} + \overrightarrow{HG} = \underline{b} + 8\underline{b} = 9\underline{b}$$

$$\overrightarrow{EG} = \overrightarrow{ED} + \overrightarrow{DG} = -\underline{a} + 9\underline{b}$$

$$EF : FG = 1 : 3 \text{ so } \overrightarrow{EF} = \frac{1}{4}\overrightarrow{EG}$$

$$\overrightarrow{EF} = \frac{1}{4}(-\underline{a} + 9\underline{b}) = -\frac{1}{4}\underline{a} + \frac{9}{4}\underline{b}$$

$$\overrightarrow{DF} = \overrightarrow{DE} + \overrightarrow{EF} = \underline{a} - \frac{1}{4}\underline{a} + \frac{9}{4}\underline{b}$$

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

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

$$\overrightarrow{DF} = 3\overrightarrow{DX} \text{ (from part (a))}$$

$\overrightarrow{DF}$ is a multiple of $\overrightarrow{DX}$, so DF and DX are parallel

and they share the point D.

Yes, DXF is a straight line.

Turn over for the next question



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]***Upper bound of $a = 4.725$* *Lower bound of $b = 157.5$* *Upper bound of $\frac{a}{b} = 4.725 \div 157.5$* *$= 0.03$* Answer *0.03*

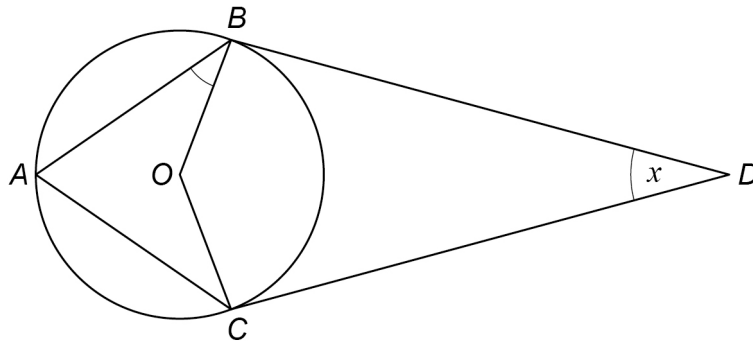
29

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]

$\text{Angle } OBD = \text{angle } OCD = 90^\circ$ (tangent meets the radius at 90°)

$\text{Angle } BOC = 360^\circ - 90^\circ - 90^\circ - x = 180^\circ - x$

(angles in a quadrilateral add up to 360°)

$\text{Angle } BAC = \frac{180^\circ - x}{2} = 90^\circ - \frac{x}{2}$

(angle at the circumference is half the angle at the centre)

$\text{Reflex angle } BOC = 360^\circ - (180^\circ - x) = 180^\circ + x$

(angles around a point add up to 360°)

In $ABOC$: $ABO + ACO = 360^\circ - (90^\circ - \frac{x}{2}) - (180^\circ + x) = 90^\circ - \frac{x}{2}$

(angles in a quadrilateral add up to 360°)

$ABDC$ is a kite, so it is symmetrical about AD : $ABO = ACO$

$ABO = \frac{1}{2}(90^\circ - \frac{x}{2}) = 45^\circ - \frac{x}{4}$



30

A sphere has radius r cmAn 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]

$$r_2 = \sqrt{239 \div 7} = 5.843188953...$$

$$r_3 = \sqrt{239 \div 5.843188953...} = 6.395492371...$$

$$r_2 = 5.843188...$$

$$r_3 = 6.395492...$$

30 (b)

Continue the iteration to work out the radius to 1 decimal place.

[1 mark]

$$r_4 = 6.113106... \quad r_5 = 6.252705... \quad r_6 = 6.182511...$$

$$r_7 = 6.217509... \quad r_8 = 6.199986... \quad r_9 = 6.208741...$$

 r_6 to r_9 all round to 6.2

Answer 6.2 cm

END OF QUESTIONS



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3 2



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