

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

GCSE MATHEMATICS

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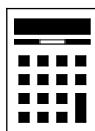
Higher Tier Paper 2 Calculator

Thursday 7 November 2019 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.
- 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	
TOTAL	

Advice

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



N 0 V 1 9 8 3 0 0 2 H 0 1

Answer **all** questions in the spaces provided

- 1 Expand $4x^2(3x + 5)$
Circle your answer.

[1 mark]

$32x^3$

$12x^3 + 20x^2$

$7x^3 + 9x^2$

$12x^2 + 5$

- 2 How many millimetres are there in a kilometre?
Circle your answer.

[1 mark]

10^3

10^5

10^6

10^9

- 3 Circle the number half way between $\frac{7}{12}$ and $\frac{3}{4}$

[1 mark]

$\frac{7}{32}$

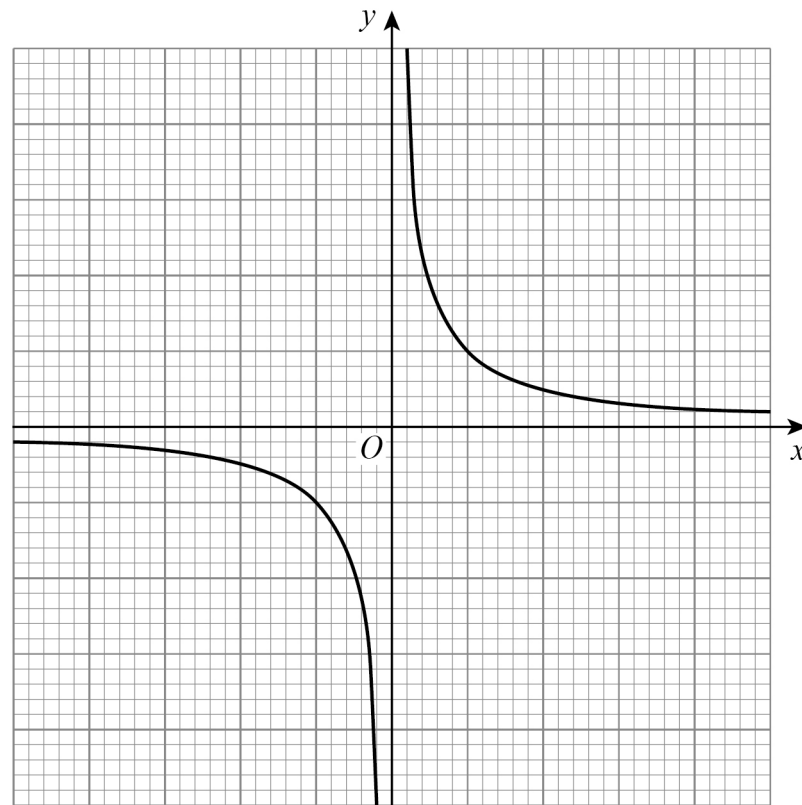
$\frac{5}{8}$

$\frac{2}{3}$

$\frac{1}{2}$



- 4 Here is the sketch of a graph.



Circle the equation of the graph.

[1 mark]

$y = x$

$y = -x^2$

$y = -x^3$

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

- 5 Work out the lowest common multiple (LCM) of 120 and 144

[2 marks]

$$120 = 2 \times 2 \times 2 \times 3 \times 5 = 2^3 \times 3 \times 5$$

$$144 = 2 \times 2 \times 2 \times 2 \times 3 \times 3 = 2^4 \times 3^2$$

$$LCM = 2^4 \times 3^2 \times 5$$

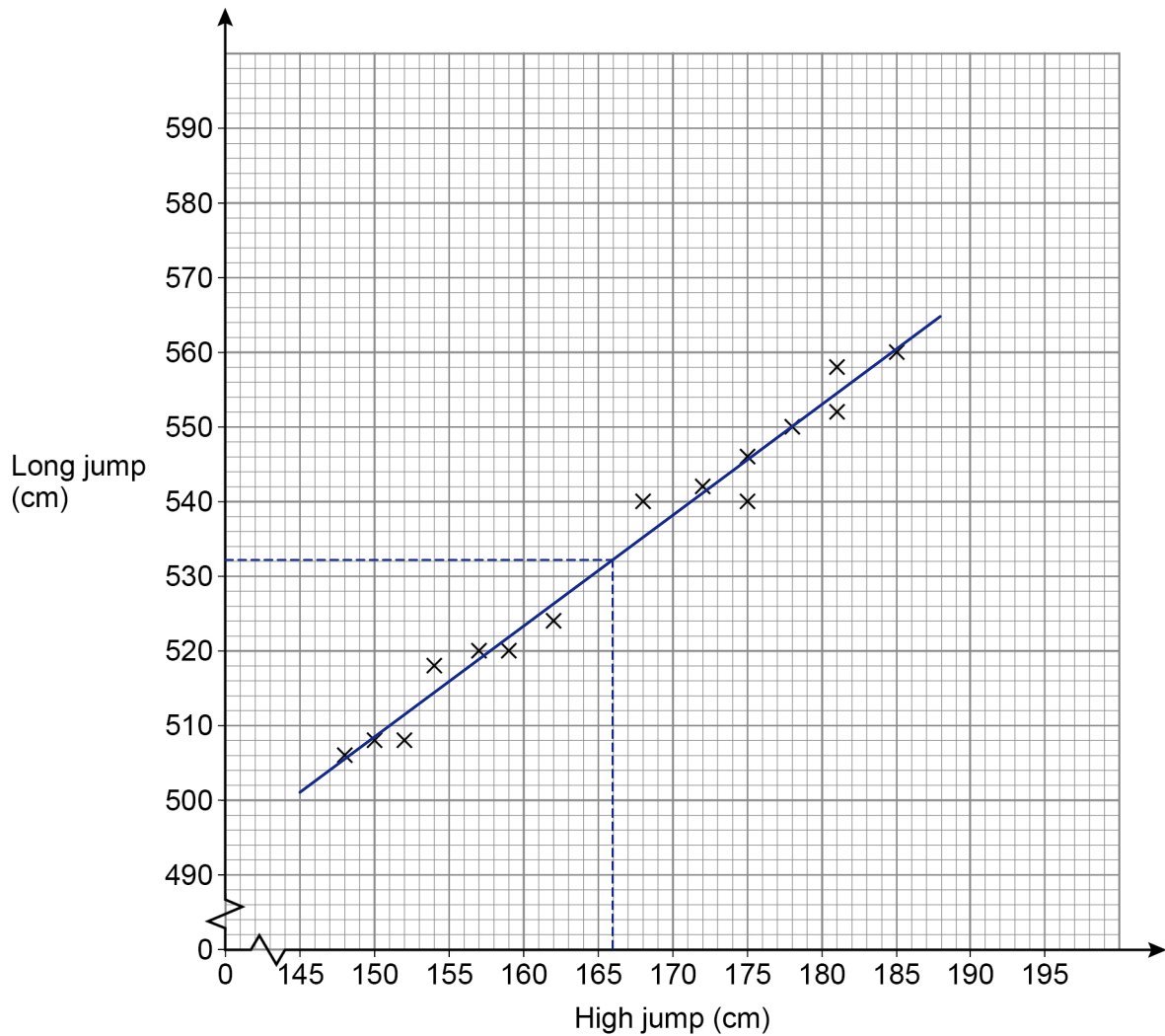
$$= 16 \times 9 \times 5 = 720$$

Answer 720

Turn over ►



- 6 The scatter graph shows the best high jump and the best long jump for 15 boys.



- 6 (a) Write down the type of correlation shown.

[1 mark]

Answer positive



- 6 (b) Liam has a best high jump of 166 cm

Use a line of best fit to estimate his best long jump.

[2 marks]

Answer 532 cm

- 6 (c) Another boy has a best high jump of 195 cm

Give a reason why you should **not** use a line of best fit to estimate his best long jump.

[1 mark]

195 cm is outside the range of the data (the highest jump

is 185 cm), so this would be extrapolation.

Turn over for the next question

Turn over ►



- 7** A car journey is in two stages.
 Stage 1 The car travels 110 miles in 2 hours.
 Stage 2 The car travels 44 miles at the same average speed as Stage 1
 Work out the time for Stage 2
 Give your answer in minutes.
- [3 marks]**

$$\text{Speed} = 110 \div 2 = 55 \text{ mph}$$

$$\text{Time} = 44 \div 55 = 0.8 \text{ hours}$$

$$0.8 \times 60 = 48 \text{ minutes}$$

Answer 48 minutes

- 8** Here is an identity.
- $$a(3x - 10) \equiv 21x + 2b$$
- Work out the values of a and b .
- [3 marks]**

$$3ax - 10a \equiv 21x + 2b$$

$$\text{Compare } x \text{ terms: } 3a = 21$$

$$a = 7$$

$$\text{Compare numbers: } -10a = 2b$$

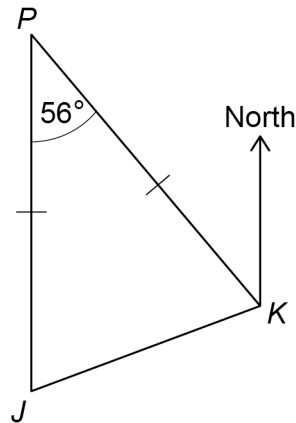
$$-70 = 2b$$

$$b = -35$$

$a =$ 7 $b =$ -35



9

 J and K are ships. P is a port. J is due South of P .Angle $JPK = 56^\circ$ $JP = KP$ Not drawn
accuratelyWork out the bearing of J from K .**[3 marks]**

Triangle JPK is isosceles: angle $PJK = \text{angle } PKJ = (180 - 56) \div 2 = 62^\circ$

South line at K is parallel to PJ , so angle between South and $KJ = 62^\circ$

(alternate angles)

Bearing of J from $K = 180 + 62 = 242^\circ$

Answer 242°

Turn over for the next question

Turn over ►



10

The 5th term of a linear sequence is 17

The 6th term of the sequence is 21

Work out the 100th term of the sequence.

[3 marks]

$$\text{Common difference} = 21 - 17 = 4$$

$$\text{1st term} = 17 - 4 \times 4 = 1, \quad \text{nth term} = 4n - 3$$

$$\text{100th term} = 4 \times 100 - 3$$

$$= 397$$

Answer 397

11

The value of a house is £120 000

The value is expected to increase by 5% each year.

Work out the expected value after 4 years.

Give your answer to 2 significant figures.

You **must** show your working.**[4 marks]**

$$\text{Multiplier} = 1.05$$

$$120\,000 \times 1.05^4$$

$$= 145\,860.75$$

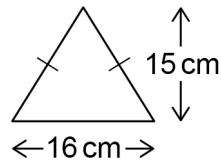
$$= 150\,000 \text{ (2 s.f.)}$$

Answer £ 150 000



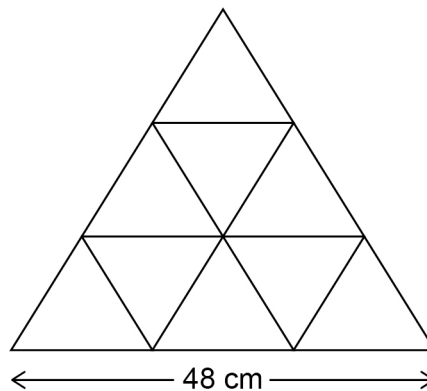
12

An isosceles triangle has base 16 cm and perpendicular height 15 cm



Not drawn
accurately

Some of these triangles are used to make a large triangle.



Not drawn
accurately

Work out the perimeter of the large triangle.

[4 marks]

$$\text{Half the base} = 16 \div 2 = 8 \text{ cm}$$

$$\text{Sloping side}^2 = 8^2 + 15^2 = 64 + 225 = 289$$

$$\text{Sloping side} = \sqrt{289} = 17 \text{ cm}$$

$$\text{Large triangle: each sloping side} = 3 \times 17 = 51 \text{ cm}$$

$$\text{base} = 48 \text{ cm}$$

$$\text{Perimeter} = 6 \times 17 + 3 \times 16$$

$$= 102 + 48 = 150$$

Answer 150 cm



- 13** 200 people recorded the time they spent on social media one day.
The table shows the results.

Time, t (mins)	Frequency	Midpoint	$f \times m$
$0 \leq t < 30$	24	15	360
$30 \leq t < 50$	76	40	3040
$50 \leq t < 60$	52	55	2860
$60 \leq t < 90$	48	75	3600
Total = 200			9860

- 13 (a)** Work out an estimate of the mean time.

[3 marks]

$$\Sigma fm = 15 \times 24 + 40 \times 76 + 55 \times 52 + 75 \times 48$$

$$= 360 + 3040 + 2860 + 3600$$

$$= 9860$$

$$\text{Mean} = 9860 \div 200$$

$$= 49.3$$

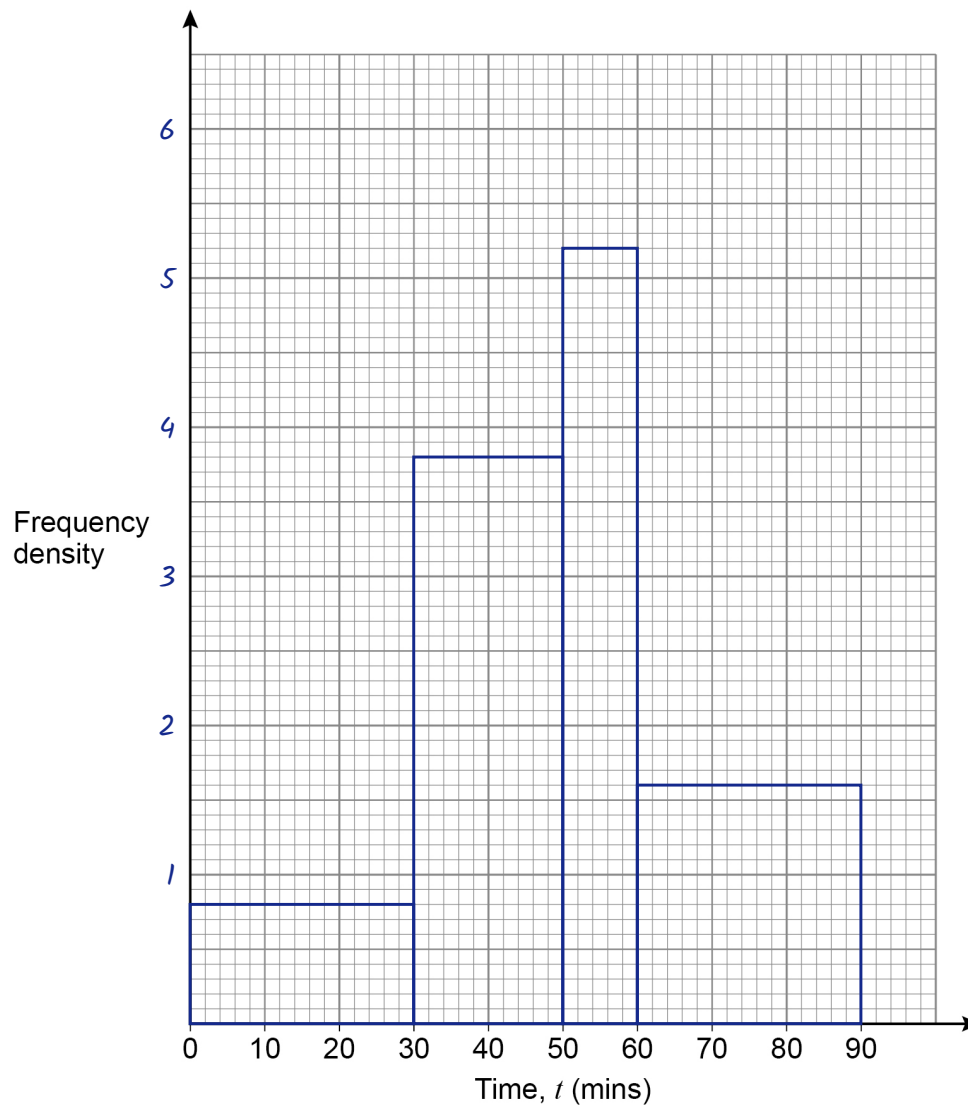
Answer 49.3 mins



13 (b) Draw a histogram to represent the results.

[4 marks]

Time, t (mins)	Frequency	Class width	Freq. density
$0 \leq t < 30$	24	30	0.8
$30 \leq t < 50$	76	20	3.8
$50 \leq t < 60$	52	10	5.2
$60 \leq t < 90$	48	30	1.6



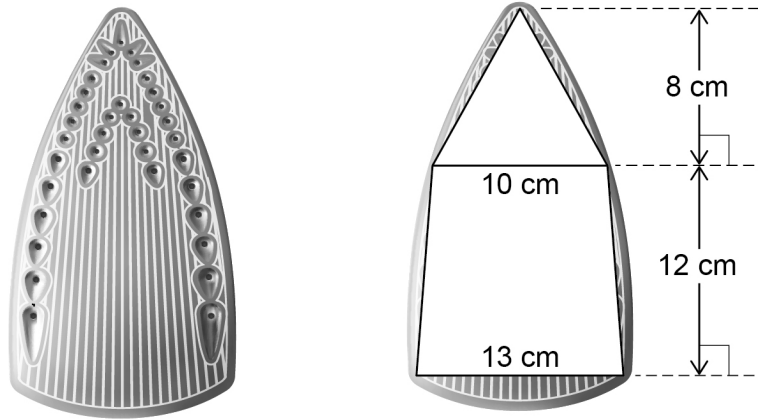
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14

Ralf has an iron.

He models the base as a triangle joined to a trapezium.

Not drawn
accurately

- 14 (a) The iron applies a force of 25 newtons (N)

$$\text{pressure} = \frac{\text{force}}{\text{area}}$$

Work out the pressure using Ralf's model.

[4 marks]

$$\text{Trapezium area} = \frac{1}{2} \times (10 + 13) \times 12 = 138 \text{ cm}^2$$

$$\text{Triangle area} = \frac{1}{2} \times 10 \times 8 = 40 \text{ cm}^2$$

$$\text{Total area} = 138 + 40 = 178 \text{ cm}^2$$

$$\text{Pressure} = \frac{25}{178}$$

$$= 0.140449...$$

$$= 0.14$$

Answer 0.14 N/cm²

- 14 (b)** Is the actual pressure greater than, equal to or less than your answer to part (a)?
Tick **one** box.

☐

greater than

☐

equal to

☒

less than

Give a reason for your answer.

[2 marks]

The real base has a bigger area than the model (the model misses the curved edges), so 25 N is divided by a bigger area, giving a smaller pressure.

- 15** Rearrange $y = \sqrt{w^3}$ to make w the subject.
Circle your answer.

[1 mark]

$$w = y^6$$

$$w = \sqrt[3]{y^2}$$

$$w = \sqrt{y^3}$$

$$w = y^5$$

Turn over for the next question

Turn over ►



16 (a) Show that $a\%$ of $b = b\%$ of a

[1 mark]

$$a\% \text{ of } b = \frac{a}{100} \times b = \frac{ab}{100}$$

$$b\% \text{ of } a = \frac{b}{100} \times a = \frac{ab}{100}$$

Both equal $ab \div 100$, so $a\%$ of $b = b\%$ of a

16 (b) Rosie says,

"160% of 40 = 140% of 60 because $a\%$ of $b = b\%$ of a "

Is she correct?

Tick a box.

☐

Yes

☒

No

Give a reason for your answer.

[1 mark]

160% of 40 = 40% of 160 (= 64), not 140% of 60.

140% of 60 = 84, which is not 64.



- 17** A packet contains 80 sweets.
The flavour of each sweet is lemon, orange or apple.
A sweet is taken at random.

- 17 (a)** $P(\text{lemon or orange}) \leq 0.85$

Work out the minimum possible number of **apple** sweets in the packet.

[2 marks]

$$P(\text{apple}) \geq 1 - 0.85 = 0.15$$

$$\text{Apple} \geq 0.15 \times 80 = 12$$

Answer 12

- 17 (b)** $P(\text{lemon or apple}) < 0.71$
There are 31 lemon sweets.

Work out the maximum possible number of **apple** sweets in the packet.

[2 marks]

$$\text{Lemon} + \text{apple} < 0.71 \times 80 = 56.8, \text{ so at most } 56$$

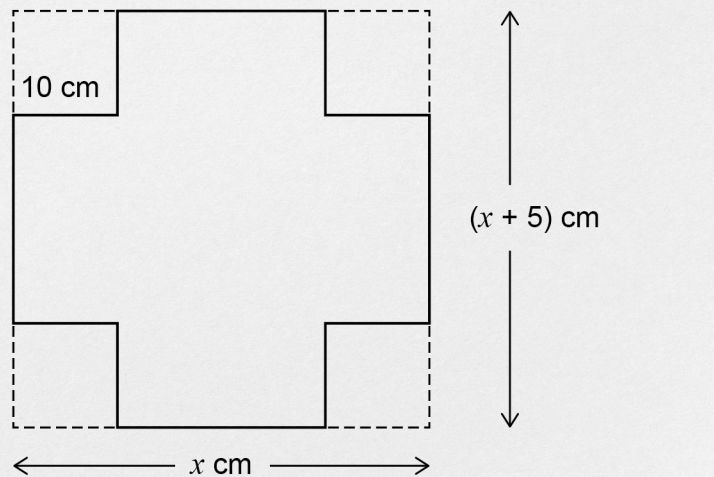
$$\text{Apple} \leq 56 - 31 = 25$$

Answer 25



- 18 Kate has the following question for homework.

The net of a box is made by cutting four squares from a piece of cardboard.
The cardboard is a rectangle with width x cm and length $(x + 5)$ cm
Each square has side length 10 cm
The area of the net is 1000 cm^2
Work out the value of x .



- 18 (a) Show that Kate can form the equation $x^2 + 5x - 1400 = 0$

[3 marks]

$$\text{Area of rectangle} = x(x + 5) = x^2 + 5x$$

$$\text{Area of four squares} = 4 \times 10^2 = 400$$

$$\text{Area of net: } x^2 + 5x - 400 = 1000$$

$$x^2 + 5x - 400 - 1000 = 0$$

$$x^2 + 5x - 1400 = 0$$



18 (b) Kate correctly factorises the equation to get $(x + 40)(x - 35) = 0$

Her answer to the homework question is $x = -40$ or $x = 35$

Is her answer correct?

Tick a box.

☐

Yes

☒

No

Give a reason for your answer.

[1 mark]

x is a length so it cannot be negative: x = 35 only,

not x = -40

19 Circle the word that describes the graph $y = \sin x$

[1 mark]

periodic

exponential

cubic

quadratic

20 (7, 28) is a point on the graph $y = f(x)$

Circle the point which **must** be on the graph $y = f(x) + 2$

[1 mark]

(7, 26)

(7, 30)

(5, 28)

(9, 28)



21

n is the middle integer of three consecutive positive integers.

The three integers are multiplied to give a product.

n is then added to the product.

Prove that the result is a cube number.

[4 marks]

The three integers are $n - 1$, n and $n + 1$

Product = $(n - 1) \times n \times (n + 1)$

$$= n(n^2 + n - n - 1)$$

$$= n(n^2 - 1)$$

$$= n^3 - n$$

Add n : $n^3 - n + n$

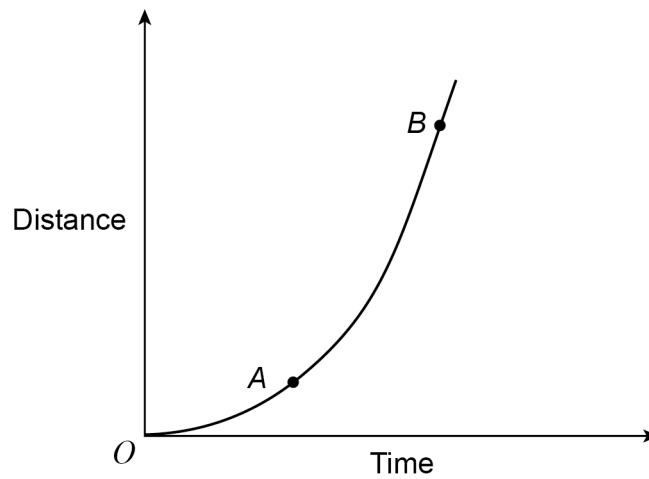
$$= n^3$$

n is an integer, so n^3 is a cube number.



22

Here is a sketch of a distance-time graph.

Which of these represents the average speed between A and B ?Tick **one** box.

[1 mark]

☐
The gradient of the tangent at A
☐
The gradient of the tangent at B
☒
The gradient of the chord from A to B
☐
The gradient of the chord from O to B

Turn over for the next question

Turn over ►

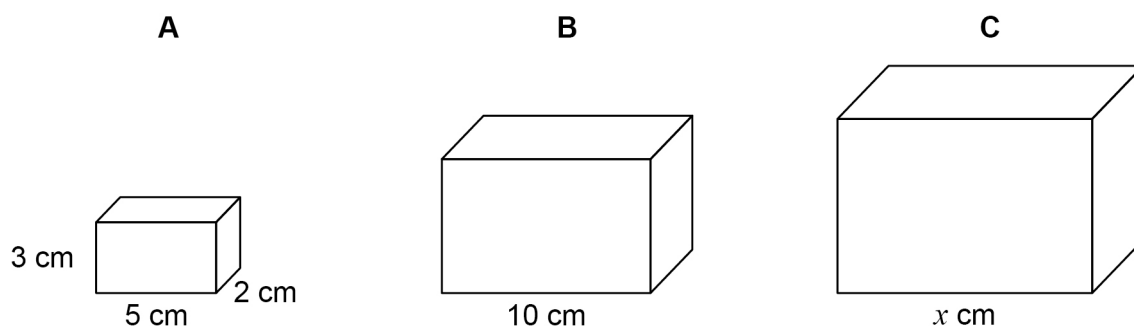


23 Here are three similar cuboids, A, B and C.

A has length 5 cm, width 2 cm and height 3 cm

B has length 10 cm

C has length x cm



- 23 (a) The total surface area of A is 62 cm^2
Tim wants to work out the total surface area of B.
Here is his working.

$$\begin{aligned} 10 \div 5 &= 2 \\ 62 \times 2 &= 124 \\ \text{Total surface area of B} &= 124 \text{ cm}^2 \end{aligned}$$

Make **one** criticism of Tim's method.

[1 mark]

*Areas scale by the square of the length scale factor, so he
should multiply by $2^2 = 4$, not 2: $62 \times 4 = 248 \text{ cm}^2$*



23 (b) Volume of A $\times \frac{125}{8}$ = Volume of C

Work out the value of x .

[3 marks]

$$\text{Volume scale factor} = 125 \div 8 = 15.625$$

$$\text{Length scale factor} = \sqrt[3]{15.625} = 2.5$$

$$x = 5 \times 2.5$$

$$x = 12.5$$

Answer 12.5

Turn over for the next question

Turn over ►



24

Here are two inequalities.

$$-2 \leq x \leq 3$$

$$9 \leq x + y \leq 11$$

 x and y are integers.Work out the **greatest** possible value of $y - x$ **[3 marks]***For $y - x$ to be greatest, x is as small as possible**and y is as large as possible.*

$$x = -2$$

$$x + y = 11 \rightarrow y = 11 - (-2) = 13$$

$$y - x = 13 - (-2) = 15$$

Answer 15

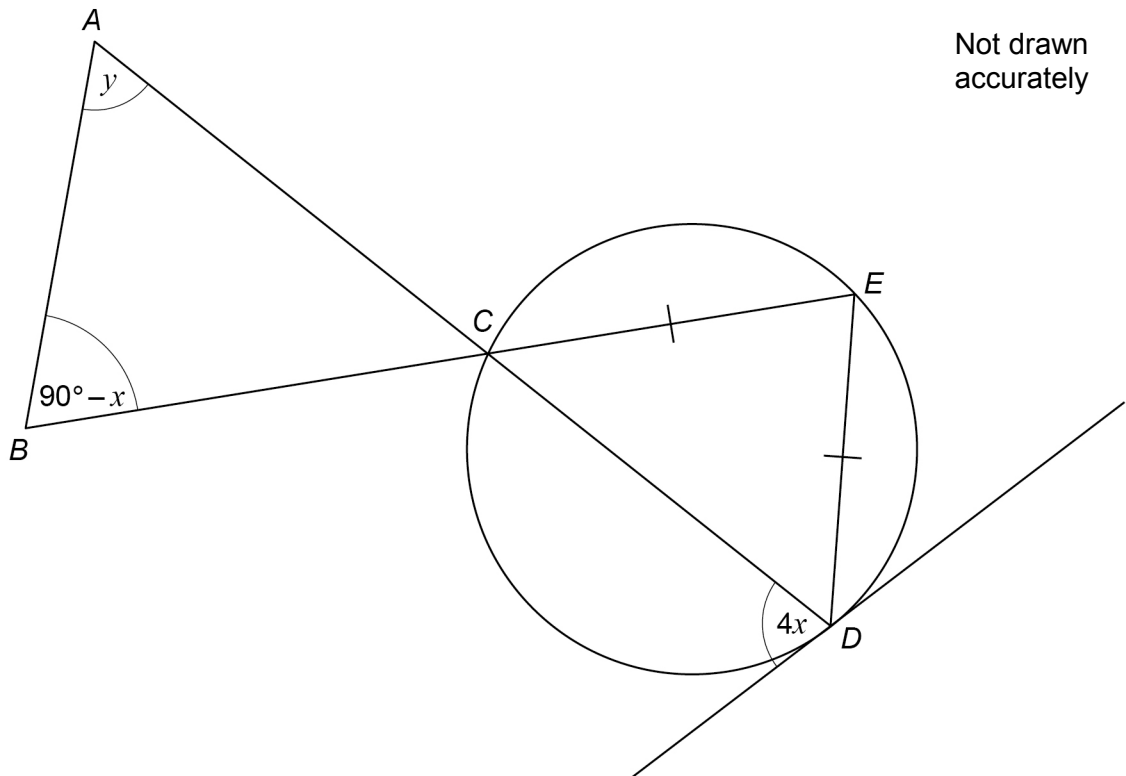
25

C , D and E are points on a circle.

$$CE = DE$$

The tangent at D is shown.

ACD and BCE are straight lines.



Prove that $y = 3x$

[4 marks]

Angle CED = $4x$ (alternate segment theorem)

$CE = DE$ so triangle CDE is isosceles (base angles are equal)

Angle DCE = $(180 - 4x) \div 2 = 90 - 2x$

Angle ACB = angle DCE = $90 - 2x$ (vertically opposite angles)

Angles in a triangle sum to 180° , so in triangle ABC:

$$y + (90 - x) + (90 - 2x) = 180$$

$$y + 180 - 3x = 180$$

$$y = 3x$$

Turn over ►



26

 P , Q and R have positive values. P is directly proportional to the square of Q .When $P = 1.25$, $Q = 0.5$ Q is inversely proportional to R .When $Q = 0.5$, $R = 6$ Work out the value of R when $P = 0.8$ **[5 marks]**

$$P = kQ^2: 1.25 = k \times 0.5^2$$

$$k = 1.25 \div 0.25 = 5, \text{ so } P = 5Q^2$$

$$Q = \frac{c}{R}: 0.5 = \frac{c}{6}, \text{ so } c = 3, Q = \frac{3}{R}$$

$$\text{When } P = 0.8: 0.8 = 5Q^2$$

$$Q^2 = 0.8 \div 5 = 0.16$$

$$Q = 0.4 \text{ (} Q \text{ is positive)}$$

$$0.4 = \frac{3}{R} \text{ so } R = 3 \div 0.4$$

$$R = 7.5$$

Answer 7.5

27

$$x_{n+1} = \sqrt[3]{3x_n + 7}$$

Use a starting value of $x_1 = 2$ to work out a solution to $x = \sqrt[3]{3x + 7}$

Give your answer to 3 decimal places.

[3 marks]

$$x_2 = \sqrt[3]{(3 \times 2 + 7)} = \sqrt[3]{13} = 2.351334...$$

$$x_3 = \sqrt[3]{(3 \times 2.351334... + 7)} = 2.413237...$$

$$x_4 = 2.423820...$$

$$x_5 = 2.425620...$$

$$x_6 = 2.425926...$$

$$x_7 = 2.425978...$$

$$x_8 = 2.425986...$$

$x_5, x_6, x_7, \dots$ all round to 2.426 (3 d.p.)

Answer 2.426

END OF QUESTIONS

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2 8



1 9 B G 8 3 0 0 / 2 H