Surname	Centre Number	Candidate Number
First name(s)		0

GCSE

C300UB0-1

A21-C300UB0-1

THURSDAY, 4 NOVEMBER 2021 – MORNING

MATHEMATICS – Component 2
Calculator-Allowed Mathematics
HIGHER TIER

2 hours 15 minutes

ADDITIONAL MATERIALS

A calculator will be required for this examination.

A ruler, protractor and a pair of compasses may be required.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.
Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

Write your name, centre number and candidate number in the spaces at the top of this page.

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

If you run out of space, use the additional pages at the back of the booklet, taking care to number the question(s) correctly.

Take π as 3·142 or use the π button on your calculator.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded of the need for good English and orderly, clear presentation in your answers.

For Examiner's use only		
Question	**Maximum Mark**	**Mark Awarded**
1.	**5**	
2.	**3**	
3.	**4**	
4.	**8**	
5.	**6**	
6.	**5**	
7.	**5**	
8.	**5**	
9.	**7**	
10.	**7**	
11.	**4**	
12.	**4**	
13.	**8**	
14.	**6**	
15.	**8**	
16.	**5**	
17.	**4**	
18.	**4**	
19.	**7**	
20.	**10**	
21.	**5**	
Total	**120**	

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NOV21C300UB0101

Formula list

Area and volume formulae

Where r is the radius of the sphere or cone, l is the slant height of a cone and h is the perpendicular height of a cone:

Curved surface area of a cone = πrl

Surface area of a sphere = $4\pi r^2$

Volume of a sphere = $\frac{4}{3}\pi r^3$

Volume of a cone = $\frac{1}{3}\pi r^2 h$

Kinematics formulae

Where a is constant acceleration, u is initial velocity, v is final velocity, s is displacement from the position when $t = 0$ and t is time taken:

$$v = u + at$$

$$s = ut + \frac{1}{2}at^2$$

$$v^2 = u^2 + 2as$$

Examiner only

1. *(a)* Solve $6x - 1 = 5 + x$. [2]

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(b) Abby, Ben and Ceri are solving a puzzle.

Abby takes x seconds.
Ben takes 5 seconds more than Abby.
Ceri takes twice as long as Ben.

Ceri takes 116 seconds to solve the puzzle.

Use an algebraic method to find how long Abby takes to solve the puzzle.

You must show all your working. [3]

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Abby takes ..... seconds

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2. Tori's grandfather buys a gold coin for her on the day she is born.
The coin costs £130.
The value of the coin is expected to increase by 6% each year.

What value is the coin expected to have on Tori's 10th birthday?
Give your answer correct to the nearest penny. [3]

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Expected value of the coin £ .....

Examiner only

3. The circumference of a circle is 40·841 cm.

Find the area of this circle.
You must show all your working. [4]

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Area of circle = ... cm^2

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4. *(a)* The diagram shows the side view of a design for a ramp to a building.

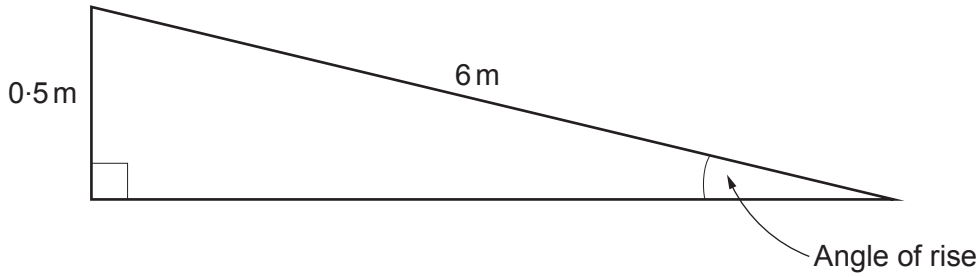

Diagram not drawn to scale

For the design to be approved, the angle of rise must not be more than 4·8°.

Use calculations to show that the design should be approved. [3]

Examiner only

(b)

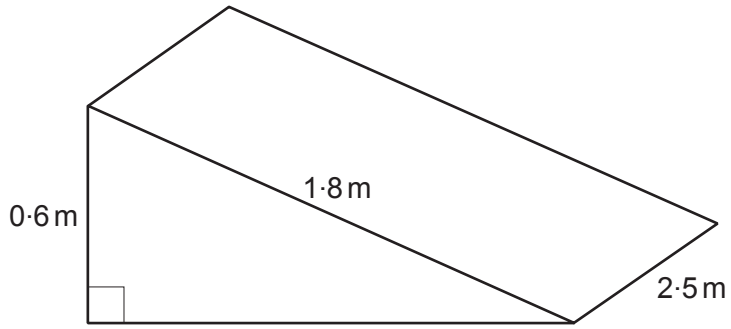

Diagram not drawn to scale

The diagram shows a concrete ramp to a different building.
It was not approved and needs to be completely removed.

The ramp is a triangular prism and is 2·5 m wide.

How many cubic metres of concrete will need to be removed?
You must show all your working. [5]

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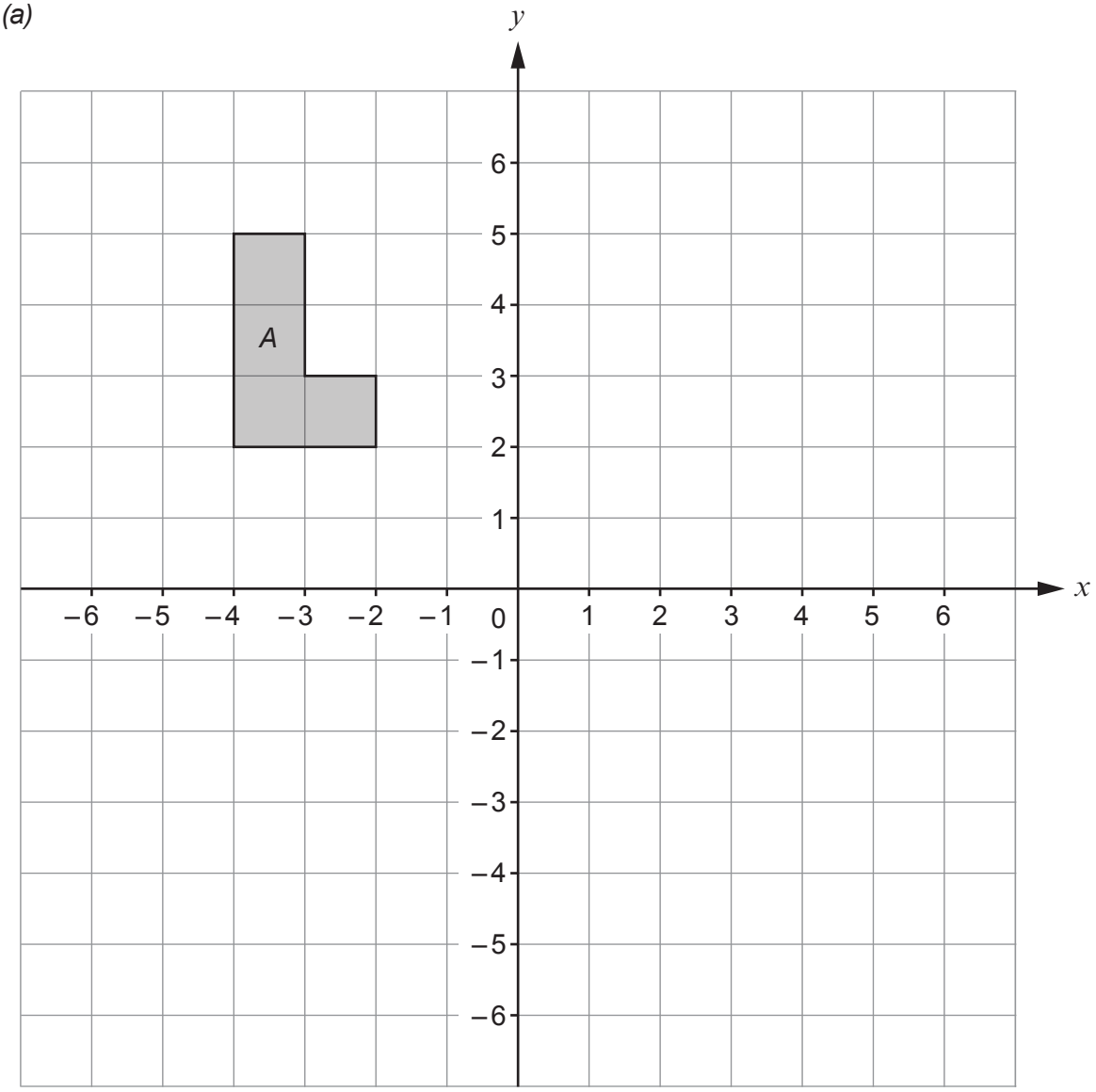
5. *(a)*



p and **q** are translation vectors with

$$\mathbf{p} = \begin{pmatrix} 3 \\ -5 \end{pmatrix} \text{ and } \mathbf{q} = \begin{pmatrix} 1 \cdot 5 \\ 2 \end{pmatrix}.$$

Shape *A* is mapped to shape *B* using $\mathbf{p} + 2\mathbf{q}$.

(i) Find the column vector which translates shape *A* to shape *B*. [2]

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Examiner only

(ii) Draw and label shape *B* on the grid on page 8. [2]

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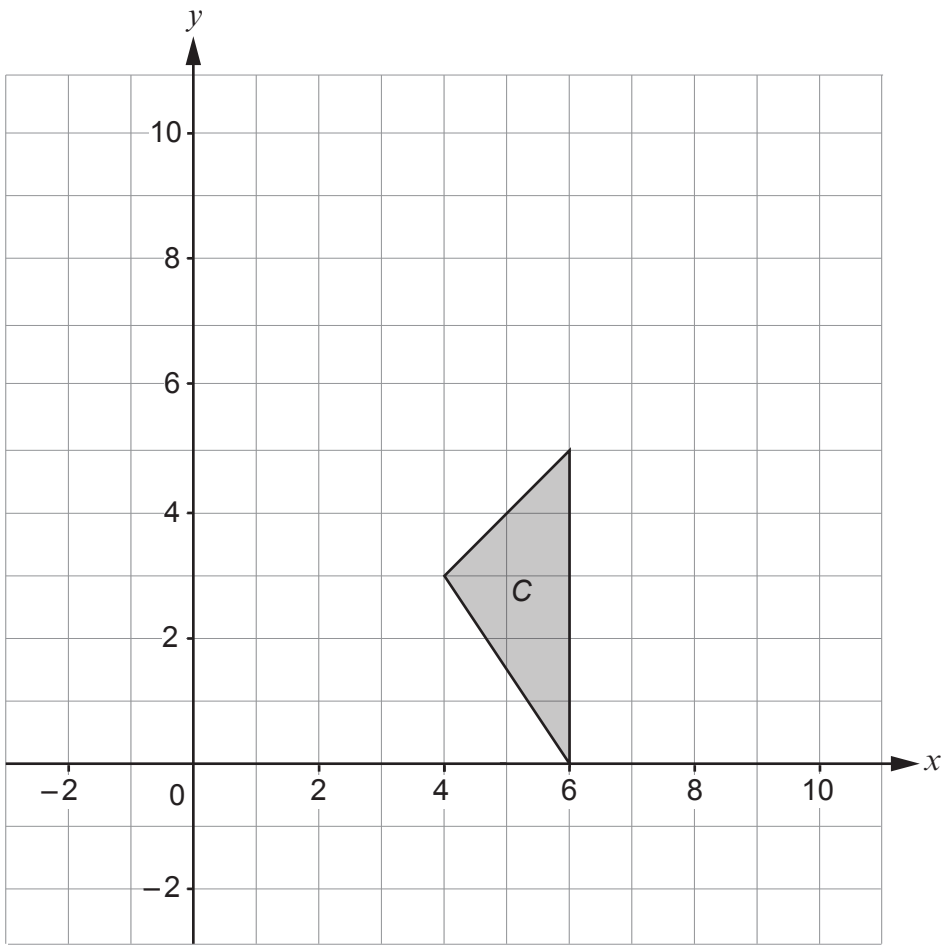
(b) Triangle *C* has vertices with coordinates (4, 3), (6, 5), (6, 0).
After a **single** transformation, the vertices of triangle *C* are mapped to (3, 4), (5, 6), (0, 6).

Describe the transformation. [2]

You may use this grid to help you



Transformation: .....

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6. A tram company sells all-day tickets.

1 adult ticket and 4 child tickets cost a total of £16.30.
2 adult tickets and 3 child tickets cost a total of £19.10.

Use an algebraic method to find the total cost of 3 adult tickets and 1 child ticket. [5]

Total cost of 3 adult tickets and 1 child ticket = £ .....

Examiner only

7. *(a)* Expand and simplify $(x-6)(7x+5)$. [3]

(b) Factorise y^2+2y-8. [2]

Examiner only

8. The table shows the time, t minutes, taken by 600 people travelling to a flower show by car.

Time, t (minutes)	Frequency
$20 < t \leqslant 40$	68
$40 < t \leqslant 80$	186
$80 < t \leqslant 100$	238
$100 < t \leqslant 150$	108

(a) Calculate an estimate of the mean travelling time for these 600 people.
You must show all your working. [4]

(b) Road works delayed each of these 600 people by 3 minutes.

What would the mean travelling time have been without these road works? [1]

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9. The table shows some of the values of $y = x^2 - 2x - 3$ for $-2 \leqslant x \leqslant 4$.

x	−2	−1	0	1	2	3	4
$y = x^2 - 2x - 3$	5	0	−3		−3	0	5

(a) Complete the table above. [1]

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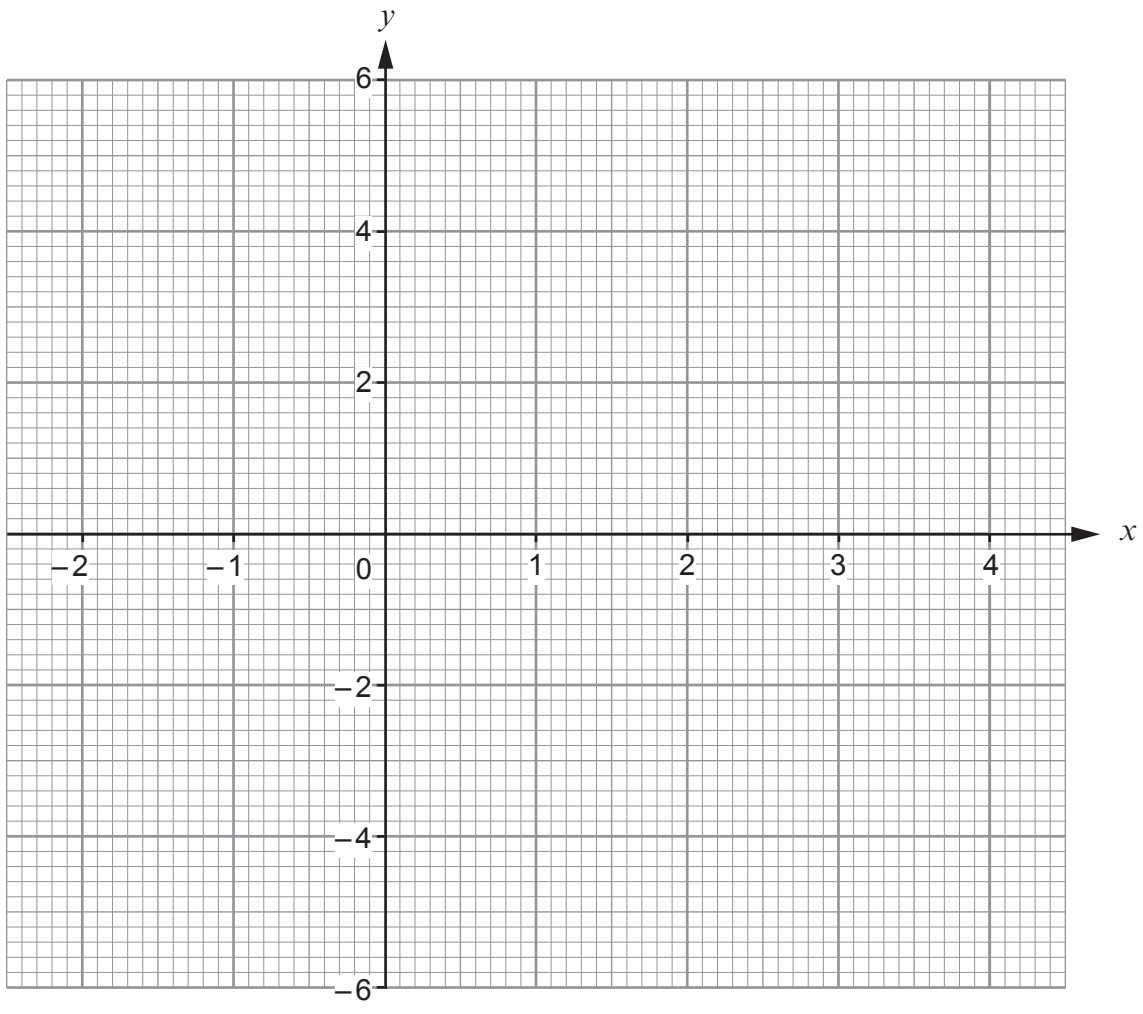
(b) On the graph paper below, draw the graph of $y = x^2 - 2x - 3$ for $-2 \leqslant x \leqslant 4$. [2]



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(c) Write down the roots of $x^2 - 2x - 3 = 0$. [1]

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(d) Use your graph to solve the simultaneous equations

$$y = x^2 - 2x - 3,$$
$$y = 1.$$ [3]

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10. *(a)* Find the next term of each of the following sequences.

(i) 2, 9, 11, 20, 31, 51, ... [1]

(ii) 1, $\sqrt{2}$, 2, $2\sqrt{2}$, 4, $4\sqrt{2}$, 8, ... [1]

(b) Find the nth term of the following sequence.

2, 6, 12, 20, 30, ... [2]

Examiner only

(c) The numbers 4, 6, and 8 are three consecutive even integers.

Complete the following proof to show that the sum of **any** three consecutive even integers is a multiple of 6. [3]

Proof:

Every even number is a multiple of 2.

Let the smallest of the three even numbers be $2n$, where n is an integer.

The second of the three even numbers must be .....

and the third of the three even numbers must be .....

Therefore .....

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11. At the start of 2018, Pavel bought a used car.

At the start of 2019, its value had reduced by 38% of the purchase price.

At the start of 2020, its value had reduced by 16% of its value at the start of 2019.

At the start of 2020, the value of Pavel's car was £6510.

What was the purchase price of the car? [4]

Examiner only

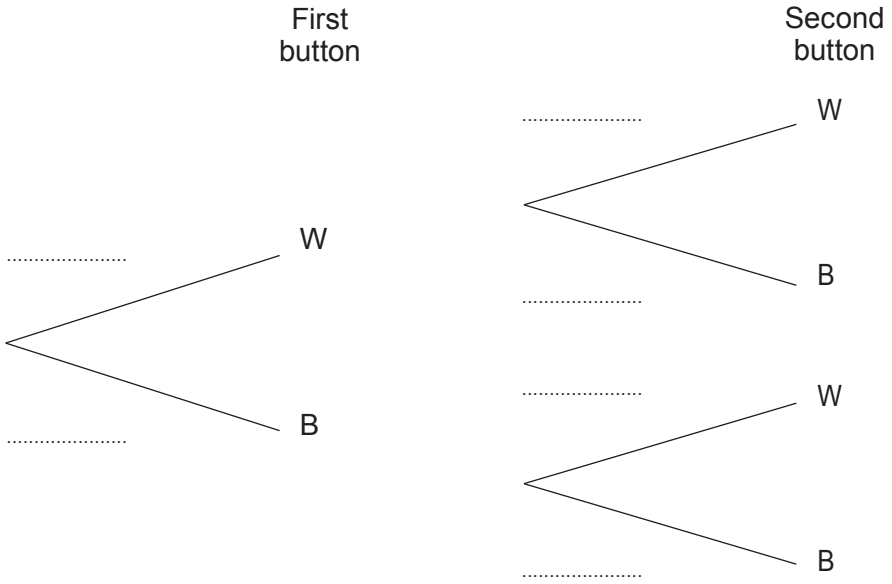
12. The equation $x^3 + x = 40$ has a solution between 3 and 4.

Use trial and improvement to find this solution correct to 1 decimal place. [4]

Examiner only

13. *(a)* Rita has a box containing 12 buttons, 5 are white (W) and the rest are blue (B). Rita takes 2 buttons from the box at random, without replacement.

Complete the tree diagram. [3]



(b) Calculate the probability that at least one of the buttons Rita takes from the box is white. [2]

Examiner only

(c) Rita puts the 2 buttons back into the box.
She then takes 3 buttons from the box at random, without replacement.

What is the probability that the second and the third buttons she takes are both blue? [3]

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Examiner only

14. At the end of 2020, the population, P_0, of a particular type of insect on an island was estimated to be 25 000.

Anwar and Irina are scientists studying these insects.

Anwar uses this iterative formula to predict the population of the insects, P_n, n years after the end of 2020.

$$P_0 = 25\,000$$

$$P_{n+1} = 1{\cdot}12P_n \quad \text{where } n \geq 0 \text{ and } n \text{ is an integer}$$

(a) Use Anwar's formula to predict the population at the end of 2021. [1]

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(b) Use Anwar's formula to predict the **increase** in population during the year 2025. You must show all your working. [3]

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Increase in population = ... insects

Examiner only

(c) The island can support a maximum of 50 000 of these insects.
When this number has been reached, the population stops increasing at the same rate.

Irina says:

"The first time that Anwar's iterative formula cannot be used to predict the population is at the end of 2027."

Is Irina correct?

Yes ☐ No ☐

Show how you decide. [2]

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15. The diagram shows a candle. It is made by removing a small pyramid of wax from the top of a large pyramid of wax, to expose the wick.

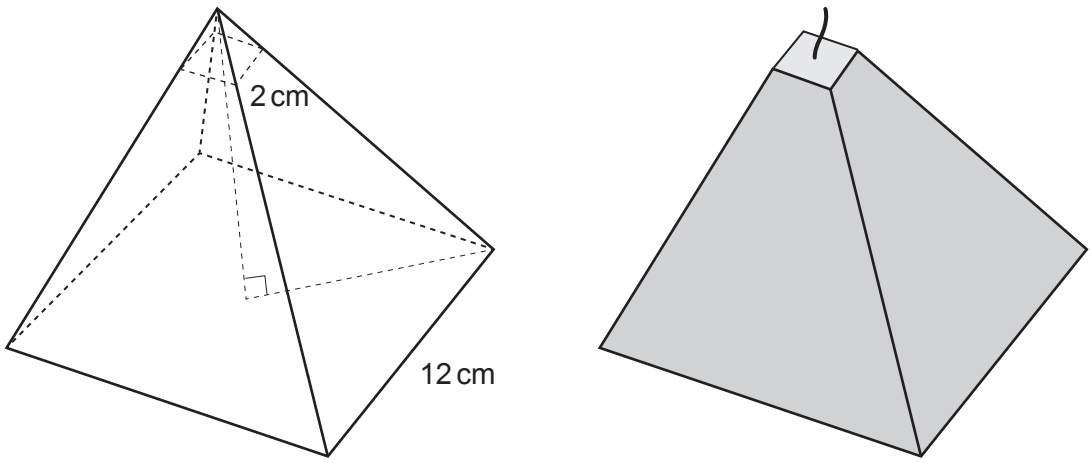

Diagram not drawn to scale

The perpendicular height of the large pyramid is 24 cm.
The base of the large pyramid is a square with sides 12 cm.
The base of the small pyramid that is removed is a square with sides 2 cm.

The density of the candle wax is $0{\cdot}9\,g/cm^3$.

$$\text{Volume of pyramid} = \frac{1}{3} \times \text{area of base} \times \text{perpendicular height}$$

(a) Calculate the mass of the candle.
State one assumption you make. [7]

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Examiner only

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Assumption: .....

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Mass of candle = ... grams

(b) Describe the impact of your assumption on your answer to part *(a)*. [1]

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Examiner only

16.

Tom rides his motorbike for 187·5 miles, correct to the nearest $\frac{1}{2}$ mile.

On this journey his motorbike uses 4·8 litres of fuel, correct to the nearest 0·4 litre.

The fuel economy of Tom's motorbike is k kilometres per litre.

What is the smallest possible value of k?

Use 1 mile = 1·6 km

[5]

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Smallest possible value of k is .....

Examiner only

17. *(a)* How many 8-digit numbers can be made using the digits 2, 3, 4, 5, 6, 7, 8, 9 when each digit is used once? [2]

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(b) How many **6-digit** numbers which start with a prime number can be made using the digits 2, 3, 4, 5, 6, 7, 8, 9 when each digit may be used at most once? [2]

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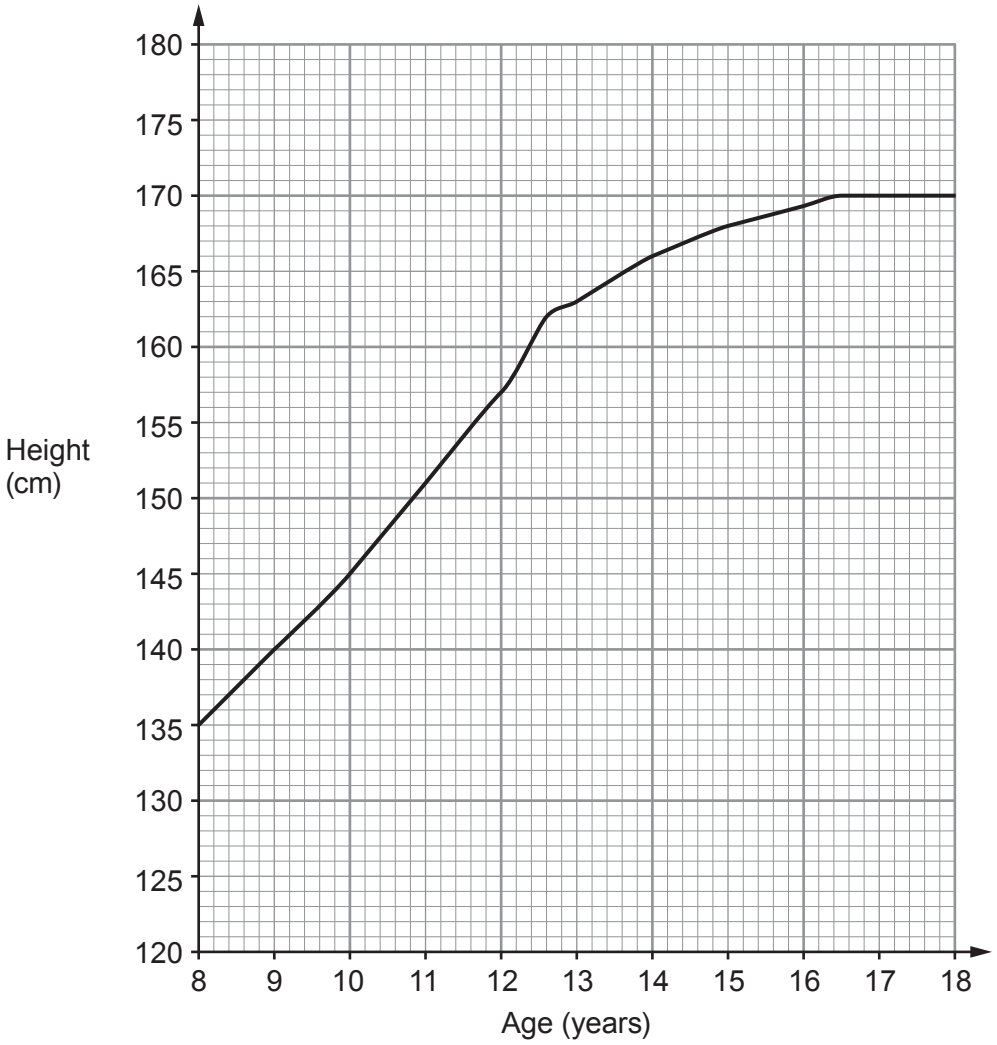
18. The diagram shows Zac's height from 8 to 18 years of age.



(a) Find Zac's rate of growth on his 17th birthday. [1]

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..... cm per year

(b) What is Zac's average rate of growth per year between his 10th and 15th birthdays? You must show all your working. [3]

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..... cm per year

Examiner only

19. Solve the following equation.

$$\frac{7}{3x+1} + \frac{4}{x+2} = 1$$

Give your answers correct to 2 decimal places. [7]

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20. The diagram shows the journey of a small boat.

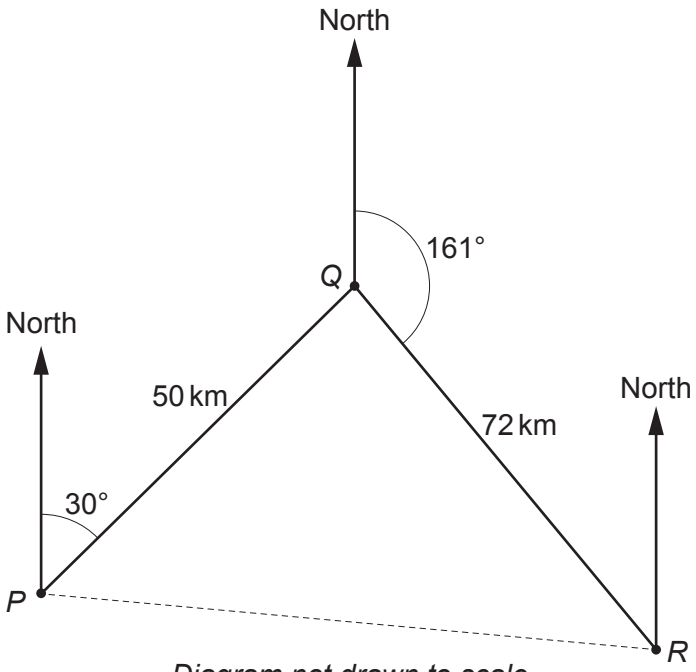

Diagram not drawn to scale

The boat sails from point *P* on a bearing of 030° for 50 km.
When it reaches point *Q*, it changes direction and travels to point *R* on a bearing of 161° for 72 km.

(a) Show that $P\hat{Q}R = 49°$. [1]

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(b) The triangular area *PQR* is to be searched to locate a shipwreck.
Calculate this area. [2]

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Area = ... km^2

Examiner only

(c) Calculate the bearing of *P* from *R*.
Give your answer correct to the nearest degree. [7]

Examiner only

21. The following probabilities are given for events A and B.

$$P(A) = 0{\cdot}3 \qquad P(B) = 0{\cdot}6 \qquad P(A \cup B) = 0{\cdot}72$$

(a) By drawing a Venn diagram or otherwise, find the probability that A occurs or B occurs but they do not both occur. [3]

(b) Find $P(A' \cap B')$. [2]

END OF PAPER

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