Instructions

- Use black ink or ball-point pen.
- Fill in the boxes at the top of this page with your name, centre number and candidate number.
- Answer all questions.
- Answer the questions in the spaces provided – there may be more space than you need.
- Calculators may be used.
- If your calculator does not have a π button, take the value of π to be 3.142 unless the question instructs otherwise.

Information

- The total mark for this paper is 100
- The marks for each question are shown in brackets – use this as a guide as to how much time to spend on each question.
- Questions labelled with an asterisk (*) are ones where the quality of your written communication will be assessed.

Advice

- Read each question carefully before you start to answer it.
- Keep an eye on the time.
- Try to answer every question.
- Check your answers if you have time at the end.
Volume of prism = area of cross section × length

Volume of sphere = \( \frac{4}{3} \pi r^3 \)
Surface area of sphere = \( 4\pi r^2 \)

Area of trapezium = \( \frac{1}{2} (a + b)h \)

Volume of cone = \( \frac{1}{3} \pi r^2 h \)
Curved surface area of cone = \( \pi rl \)

In any triangle ABC

Sine Rule \( \frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C} \)

Cosine Rule \( a^2 = b^2 + c^2 - 2bc \cos A \)

Area of triangle = \( \frac{1}{2} ab \sin C \)

The Quadratic Equation
The solutions of \( ax^2 + bx + c = 0 \)
where \( a \neq 0 \), are given by
\[
x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}
\]
Answer ALL questions.

Write your answers in the spaces provided.

You must write down all stages in your working.

1. Here are the lengths, in cm, of 15 tables.

\[
\begin{array}{ccccccc}
28 & 31 & 42 & 33 & 63 \\
38 & 44 & 29 & 32 & 37 \\
61 & 35 & 39 & 41 & 25 \\
\end{array}
\]

Draw an ordered stem and leaf diagram for these lengths.

\[
\begin{array}{c}
2 \mid 3, 5, 8, 9 \\
3 \mid 2, 5, 7, 8, 9 \\
4 \mid 1, 2, 4 \\
5 \mid 1 \\
6 \mid 1, 3 \\
\end{array}
\]

key

\[2\frac{1}{3} = 23\text{ cm}\]

(Total for Question 1 is 3 marks)
2 A delivery driver records for each delivery the distance he drives and the time taken.

The scatter graph shows this information.

For another delivery he drives 22 kilometres and takes 50 minutes.

(a) Show this information on the scatter graph.

(b) What type of correlation does the scatter graph show?

positive
The driver has to drive a distance of 10 km for his next delivery.

(c) Estimate the time taken for this delivery.

\[
\begin{align*}
\text{20 minutes} \\
\text{(2)} \quad [18 - 22] \\
\text{45 minutes} \\
(1)
\end{align*}
\]

During one of the deliveries, the driver was delayed by road works.

(d) Using the graph write down the time taken for this delivery.

(Total for Question 2 is 5 marks)

3. Ali is \(y\) years old.
   Bhavara is twice as old as Ali.
   Ceris is 3 years younger than Ali.

The total of their ages is 125 years.

Work out the age of each person.

\[
y + 2y + y - 3 = 125
\]

\[
4y - 3 = 125
\]

\[
4y = 128
\]

\[
y = 32
\]

Ali \(32\) years

Bhavara \(64\) years

Ceris \(29\) years

(Total for Question 3 is 4 marks)
4 There are 18500 gallons of fuel in a fuel tank.

The fuel is pumped from the fuel tank into a plane at a rate of 1700 litres per minute.

1 gallon = 4.5 litres.

How many minutes will it take to empty the fuel tank completely?
Give your answer to the nearest minute.

\[
\frac{1700 \text{ litres per minute}}{4.5} = \frac{3400}{9} \text{ gallons per minute} \approx 377.7
\]

\[
\frac{18500}{377.7} = 48.97058824 \text{ minutes}
\]

\[
49 \text{ minutes}
\]

(Total for Question 4 is 3 marks)
5 Celina and Zoe both sing in a band.

One evening the band plays for 80 minutes.
Celina sings for 65% of the 80 minutes.
Zoe sings for \( \frac{5}{8} \) of the 80 minutes.

Celina sings for more minutes than Zoe sings.

Work out for how many more minutes.
You must show all your working.

\[
\begin{align*}
\text{Celina:} & \quad 0.65 \times 80 = 52 \text{ mins} \\
\text{Zoe:} & \quad \frac{5}{8} \times 80 = 50 \text{ mins}
\end{align*}
\]

\[52 - 50 = 2 \text{ minutes}\]

(Total for Question 5 is 4 marks)

6 A rectangle has an area of 4 m².

Write this area in cm².

\[
\text{Scale factor } \times 100^2
\]

4 \times 100²

4 000 000 cm²

(Total for Question 6 is 2 marks)
Here is part of a field.

Diagram NOT accurately drawn

This part of the field is in the shape of a trapezium.
A farmer wants to put a fence all the way around the edge of this part of the field.

The farmer has 50 m of fence.
Does he have enough fence?
You must show all your working.

\[
\begin{align*}
7^2 + 10^2 &= x^2 \\
49 + 100 &= x^2 \\
149 &= x^2 \\
x &= \sqrt{149} \\
&= 12.2 \text{ m (1dp)}
\end{align*}
\]

\[
12.2 + 18 + 10 + 11 = 51.2 \text{ m}
\]

The farmer does not have enough fence.

(Total for Question 7 is 5 marks)
Toothpaste is sold in three different sizes of tube.

50 ml

A 50 ml tube costs £1.09

75 ml

A 75 ml tube costs £1.68

125 ml

A 125 ml tube costs £2.69

Which tube of toothpaste is the best value for money?
You must show all your working.

\[
\frac{1.09}{2.18} \text{ p per ml} \quad \frac{1.68}{2.24} \text{ p per ml} \quad \frac{2.69}{2.152} \text{ p per ml}
\]

The 125 ml tube is the best value for money.

(Total for Question 8 is 4 marks)
Use ruler and compasses to **construct** the perpendicular bisector of the line segment $AB$. You must show all your construction lines.

(Total for Question 9 is 2 marks)
A coach travels from Dronston to Luscoe.
The travel graph for this journey is shown below.

(a) Work out the average speed of the coach, in kilometres per hour, for the first 10 minutes of the journey.

\[
\text{speed} = \frac{\text{distance}}{\text{time}} = \frac{9}{10} \text{ km/min}
\]

\[
\frac{9}{10} \times 60 = 54 \text{ km/hr}
\]

The coach stops in Luscoe for 15 minutes.
The coach then returns to Dronston at a constant speed of 42 km/h.

(b) Show this information on the travel graph.

\[
42 \text{ km/hr} \quad 21 \text{ km in 30 mins}
\]

(Total for Question 10 is 5 marks)
11 (a) Solve \[ 3x^2 = 147 \]
\[
\frac{x}{3} = \frac{\sqrt[3]{49}}{3}
\]
\[ x = \pm \sqrt[3]{49} \]
\[ x = \pm 7 \]
\[ \text{+7 or -7} \]

(b) Work out the value of \(2^{-3}\)
\[ 2^{-3} = \frac{1}{2^3} = \frac{1}{8} \]
\[ \text{1/8} \]

(c) Simplify \((3x^3)^3\)
\[ 3x^2 \times 3x^2 \times 3x^2 \]
\[ 27x^6 \]
\[ \text{27x^6} \]

(d) Make \(p\) the subject of this formula.
\[ \omega = 4p - 16 \]
\[ \omega + 16 = 4p \]
\[ \frac{\omega + 16}{4} = p \]
\[ p = \frac{\omega + 16}{4} \]
\[ \text{p = } \frac{\omega + 16}{4} \]

(Total for Question 11 is 7 marks)
Describe fully the single transformation that maps triangle A onto triangle B.

**Rotation, 180°, about centre (2, 1)**

(Total for Question 12 is 3 marks)
13 (a) Given that \( x \) and \( y \) are integers such that
\[
3 < x < 7 \quad 4, 5, 6 \\
4 < y < 9 \quad 5, 6, 7, 8 \\
\text{and} \quad x + y = 13
\]
find all the possible values of \( x \).

(b) On the grid below show, by shading, the region defined by the inequalities
\[
y \geq -1 \quad y \leq 4 - x \quad y \leq 3x - 1
\]
Mark this region with the letter \( R \).
Each year Wenford Hospital records how long patients wait to be treated in the Accident and Emergency department.

In 2015 patients waited 11% less time than in 2014.
In 2015 the average time patients waited was 68 minutes.

(a) Work out the average time patients waited in 2014
   Give your answer to the nearest minute.

\[
\begin{align*}
68 \text{ mins} &= 89\% \\
0.76404... &= 1\% \\
76.404 &= 100\%
\end{align*}
\]

7.6 minutes

The hospital has a target to reduce the average time patients wait to be treated in the Accident and Emergency department to 60 minutes in 2016.

(b) Work out the percentage decrease from 68 minutes to 60 minutes.

\[
\frac{\text{Change}}{\text{original}} \times 100
\]

\[
\frac{68 - 60}{68} \times 100 = 11.76\% \quad 2\text{dp}
\]

11.76%

(Total for Question 14 is 5 marks)
B, C and D are points on the circumference of a circle, centre O. BOD is a diameter of the circle.

AO = 7 cm  Angle ABO = 90°  Angle OAB = 35°  Angle DBC = 70°

*(a) Explain why angle BCD is 90°

An angle in a semi-circle is 90°

(b) Calculate the length of BC.
Give your answer correct to 3 significant figures.

\[
\sin(35°) = \frac{x}{7} \\
7 \sin(35°) = x \\
x = 4.015035054 \text{ cm}
\]

\[
BD = 2x = 8.030070109 \text{ cm}
\]

\[
\cos(70°) = \frac{x}{8.03} \\
8.03 \cos(70°) = x \\
x = 2.74644573 \text{ cm} \\
= 2.75 \text{ cm (3 sf)}
\]
16 (a) Write $640 \ 000 \ 000$ in standard form.

\[ 6.4 \times 10^8 \]  

(b) Work out $(3 \times 10^7) \div (6 \times 10^4)$  
Give your answer in standard form.

\[
\frac{3}{6} = 0.5 \quad 10^7 \div 10^4 = 10^3 \\
0.5 \times 10^3 \\
0.5 \times 10 \times 10^2 \\
5 \times 10^2 \]

(Total for Question 16 is 3 marks)

17 $L_1$ and $L_2$ are parallel lines.

The equation of $L_1$ is $y = 3x + 2$  
$L_2$ passes through the point $(3, 4)$.

Find an equation for $L_2$.

\[
y = 3x + c \\
4 = 3(3) + c \\
4 = 9 + c \\
c = -5 \\
y = 3x - 5 \]

(Total for Question 17 is 3 marks)
The box plot shows information about the number of countries competing in each Winter Olympic Games since 1948.

(a) Write down the median.

(b) Work out the interquartile range.

\[ 71 - 35 \]

The table below shows information about the number of countries competing in each Summer Olympic Games since 1948.

<table>
<thead>
<tr>
<th>Number of countries</th>
<th>Smallest</th>
<th>Lower quartile</th>
<th>Median</th>
<th>Upper quartile</th>
<th>Largest</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>59</td>
<td>83</td>
<td>121</td>
<td>199</td>
<td>204</td>
</tr>
</tbody>
</table>

(c) Compare the two distributions.

- The median number of countries competing in the summer Olympics is higher (121) than the winter Olympics (37).
- The interquartile range of the number of countries in the summer Olympics (116) is bigger than the winter Olympics (36).

(Total for Question 18 is 5 marks)
19 The value of \( p \) is 4.3
The value of \( q \) is 0.4

Both \( p \) and \( q \) are given correct to the nearest 0.1

(a) Write down the lower bound for \( p \).

\[
r = p + \frac{1}{q}
\]

(b) Work out the upper bound for \( r \).
You must show all your working.

\[
\begin{align*}
r_{\text{upper}} &= p_{\text{upper}} + \frac{1}{q_{\text{lower}}} \\
&= 4.35 + \frac{1}{0.35} \\
&= 7.207142857 \\
&= 7.21 (3 s.d.)
\end{align*}
\]

(Total for Question 19 is 4 marks)
20 Here are two watch faces, A and B.

Both watch faces are circular with radius 2 cm.

The materials used to make both watch faces have the same thickness.

A is made entirely of plastic.
B has a 20° sector of metal and a 340° sector of plastic.

The ratio of the cost per cm² of the metal to the cost per cm² of the plastic is 3:2

Work out the ratio of the cost of the materials for A to the cost of the materials for B.
Give your answer in its simplest form.
You must show all your working.

\[
\text{Cost of metal} = \text{cost of plastic} \times 1.5
\]

\[
\begin{array}{l}
\text{Face A} \\
360 : 340 + 1.5 \times 20 \\
360 : 340 + 30 \\
360 : 370 \\
36 : 37
\end{array}
\]

36 : 37

(Total for Question 20 is 4 marks)
21 148 students went to Brighton.

Each student went to the Aquarium or the Brighton Wheel or the Royal Pavilion.

The table gives information about these students.

<table>
<thead>
<tr>
<th></th>
<th>Aquarium</th>
<th>Brighton Wheel</th>
<th>Royal Pavilion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>16</td>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>Female</td>
<td>36</td>
<td>35</td>
<td>24</td>
</tr>
</tbody>
</table>

The teacher takes a sample of 40 of these students.
The sample is stratified by gender and by place visited.

Work out the number of students in the sample who are female and went to the Brighton Wheel.

\[
\frac{35}{148} \times 40 = 9.459459459459\]

(Total for Question 21 is 2 marks)

22 Alison is using the quadratic formula to solve a quadratic equation. She substitutes values into the formula and correctly gets

\[
x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}
\]

Work out the quadratic equation that Alison is solving.
Give your answer in the form \(ax^2 + bx + c = 0\), where \(a\), \(b\) and \(c\) are integers.

\[
\begin{align*}
2a &= 4 \\
a &= 2
\end{align*}
\]

\[
\begin{align*}
b &= 7
\end{align*}
\]

\[
\begin{align*}
4ac &= 32 \\
ac &= 8 \\
2c &= 8 \\
c &= 4
\end{align*}
\]

\[
2x^2 + 7x + 4 = 0
\]

(Total for Question 22 is 3 marks)
23 Here is the graph of \( y = \sin x^\circ \) for \(-180 \leq x \leq 180\)

(a) On the grid above, sketch the graph of \( y = \sin x^\circ + 2 \) for \(-180 \leq x \leq 180\) (2)

Here is the graph of \( y = \cos x^\circ \) for \(-180 \leq x \leq 180\)

(b) On the grid above, sketch the graph of \( y = -2 \cos x^\circ \) for \(-180 \leq x \leq 180\) (2)

(Total for Question 23 is 4 marks)
24 ABC is a triangle.

\[ AC = 8.4 \text{m} \]
\[ \text{Angle } ACB = 40^\circ \]

The area of the triangle = 100 m².

Work out the length of AB.
Give your answer correct to 3 significant figures.
You must show all your working.

\[
100 = \frac{1}{2} a b \sin C
\]
\[
100 = \frac{1}{2} (8.4)(x) \sin(40)
\]
\[
100 = x \left( \frac{1}{2} (8.4) \sin(40) \right)
\]
\[
x = 37.0410425
\]

\[
a^2 = b^2 + c^2 - 2bc \cos A
\]
\[
y^2 = 8.4^2 + (37.0)^2 - 2(8.4)(37.0) \cos(40)
\]
\[
y^2 = 965.8974663
\]
\[
y = 31.07889101
\]
\[
y = 31.1 \text{ (3sf)}
\]

Diagram NOT accurately drawn

\[ \text{31.1} \text{ m} \]

(Total for Question 24 is 5 marks)
25 Nomusa has 30 sweets.

She has

- 18 fruit sweets
- 7 aniseed sweets
- 5 mint sweets

Nomusa is going to take at random two sweets.

Work out the probability that the two sweets will not be the same type of sweet. You must show all your working.

\[
P(FF) = \frac{18}{30} \times \frac{17}{29} = \frac{51}{145}
\]

\[
P(AA) = \frac{7}{30} \times \frac{6}{29} = \frac{7}{145}
\]

\[
P(MM) = \frac{5}{30} \times \frac{4}{29} = \frac{2}{87}
\]

\[
P(\text{2 same}) = \frac{51}{145} + \frac{7}{145} + \frac{2}{87} = \frac{184}{435}
\]

\[
P(\text{Not same}) = 1 - \frac{184}{435} = \frac{251}{435}
\]

(Total for Question 25 is 4 marks)