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Answer all questions.
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For \( \pi \), use either your calculator value or 3.142.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 70.
1 Use your calculator to find \( \sqrt{\frac{45 \times 5.75}{3.1 + 1.5}} \).

Answer .......................................... [2]

2 Work out \( 2(3 \times 10^8 - 4 \times 10^6) \), giving your answer in standard form.

Answer .......................................... [2]

3 Write the following in order of size, **largest** first.

\[
\sin 158^\circ \quad \cos 158^\circ \quad \cos 38^\circ \quad \sin 38^\circ
\]

Answer .......... > ............. > ............. > ............. [2]

4 Write down all the working to show that

\[
\frac{3 + \frac{2}{3}}{\frac{5 + 3}{3 \times \frac{2}{5}}} = 3 \frac{1}{6}
\]

Answer

[3]
5 A circle has a radius of 50 cm.

(a) Calculate the area of the circle in cm\(^2\).

\[ \text{Answer(a)} \ \text{cm}^2 \ [2] \]

(b) Write your answer to part (a) in m\(^2\).

\[ \text{Answer(b)} \ \text{m}^2 \ [1] \]

6 The front of a house is in the shape of a hexagon with two right angles. The other four angles are all the same size.

Calculate the size of one of these angles.

\[ \text{Answer} \ \text{[3]} \]
TA is a tangent at A to the circle, centre O.
Angle $OAB = 50^\circ$.

Find the value of

(a) $y$,

$Answer(a) y =$ .............................................. [1]

(b) $z$,

$Answer(b) z =$ .............................................. [1]

(c) $t$.

$Answer(c) t =$ .............................................. [1]

8 Seismic shock waves travel at speed $v$ through rock of density $d$.
$v$ varies **inversely** as the **square root** of $d$.

$v = 3$ when $d = 2.25$.

Find $v$ when $d = 2.56$.

$Answer v =$ .............................................. [3]
The point $A$ lies on the circle centre $O$, radius 5 cm.

(a) **Using a straight edge and compasses only**, construct the perpendicular bisector of the line $OA$. [2]

(b) The perpendicular bisector meets the circle at the points $C$ and $D$.

Measure and write down the size of the angle $AOD$.

\[ \text{Answer (b) Angle } AOD = \ \ \ \ \ \ \ \ \ ] [1]
10 In a flu epidemic 45% of people have a sore throat.  
If a person has a sore throat the probability of not having flu is 0.4.  
If a person does not have a sore throat the probability of having flu is 0.2.

Calculate the probability that a person chosen at random has flu.

\[
\begin{align*}
\text{Sore throat} & : 0.45 & & \text{Flu} & : 0.4 \\
\text{No sore throat} & : 0.2 & & \text{No flu} & : 0.2
\end{align*}
\]

Answer: 

11 Work out.

(a) \[
\left( \begin{array}{cc}
2 & 1 \\
4 & 3 \\
\end{array} \right)^2
\]

Answer(a) 

(b) \[
\left( \begin{array}{cc}
2 & 1 \\
4 & 3 \\
\end{array} \right)^{-1}
\]

Answer(b)
The scatter diagram shows the marks obtained in a Mathematics test and the marks obtained in an English test by 15 students.

(a) Describe the correlation.

Answer(a) .................................. [1]

(b) The mean for the Mathematics test is 47.3.
The mean for the English test is 30.3.

Plot the mean point (47.3, 30.3) on the scatter diagram above. [1]

(c) (i) Draw the line of best fit on the diagram above. [1]

(ii) One student missed the English test.
She received 45 marks in the Mathematics test.

Use your line to estimate the mark she might have gained in the English test.

Answer(c)(ii) .................................. [1]
A and B have position vectors \( \mathbf{a} \) and \( \mathbf{b} \) relative to the origin \( O \).

\( C \) is the midpoint of \( AB \) and \( B \) is the midpoint of \( AD \).

Find, in terms of \( \mathbf{a} \) and \( \mathbf{b} \), in their simplest form

(a) the position vector of \( C \),

(b) the vector \( \overrightarrow{CD} \).

14

\[ T = 2\pi \sqrt{\frac{\ell}{g}} \]

(a) Find \( T \) when \( g = 9.8 \) and \( \ell = 2 \).

Answer(a) \( T = \) ................................... [2]

(b) Make \( g \) the subject of the formula.

Answer(b) \( g = \) ................................... [3]
A container ship travelled at 14 km/h for 8 hours and then slowed down to 9 km/h over a period of 30 minutes. It travelled at this speed for another 4 hours and then slowed to a stop over 30 minutes. The speed-time graph shows this voyage.

(a) Calculate the total distance travelled by the ship.

Answer(a) \[ \text{km} \] [4]

(b) Calculate the average speed of the ship for the whole voyage.

Answer(b) \[ \frac{\text{km}}{\text{h}} \] [1]
The co-ordinates of $A$, $B$ and $C$ are shown on the diagram, which is not to scale.

(a) Find the length of the line $AB$.

$Answer(a) \ AB = \hspace{1cm} [3]$  

(b) Find the equation of the line $AC$.

$Answer(b) \hspace{1cm} [3]$
Question 18 is printed on the next page.
The first four terms of a sequence are
\[T_1 = 1^2 \quad T_2 = 1^2 + 2^2 \quad T_3 = 1^2 + 2^2 + 3^2 \quad T_4 = 1^2 + 2^2 + 3^2 + 4^2.\]

(a) The \(n\)th term is given by \(T_n = \frac{1}{6} n(n + 1)(2n + 1)\).

Work out the value of \(T_{23}\).

\[Answer(a) \quad T_{23} = \quad \text{[2]}\]

(b) A new sequence is formed as follows.

\[U_1 = T_2 - T_1 \quad U_2 = T_3 - T_2 \quad U_3 = T_4 - T_3 \quad \ldots\]

(i) Find the values of \(U_1\) and \(U_2\).

\[Answer(b)(i) \quad U_1 = \quad \text{and} \quad U_2 = \quad \text{[2]}\]

(ii) Write down a formula for the \(n\)th term, \(U_n\).

\[Answer(b)(ii) \quad U_n = \quad \text{[1]}\]

(c) The first four terms of another sequence are

\[V_1 = 2^2 \quad V_2 = 2^2 + 4^2 \quad V_3 = 2^2 + 4^2 + 6^2 \quad V_4 = 2^2 + 4^2 + 6^2 + 8^2.\]

By comparing this sequence with the one in part (a), find a formula for the \(n\)th term, \(V_n\).

\[Answer(c) \quad V_n = \quad \text{[2]}\]
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For π, use either your calculator value or 3.142.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 70.
1 A bus leaves a port every 15 minutes, starting at 0900.
The last bus leaves at 1730.

How many times does a bus leave the port during one day?

Answer ...................................... [2]

2 Factorise completely \( ax + bx + ay + by \).

Answer ...................................... [2]

3 Use your calculator to find the value of

(a) \( 3^0 \times 2.5^2 \),

Answer(a) ...................................... [1]

(b) \( 2.5^{-2} \).

Answer(b) ...................................... [1]

4 The cost of making a chair is $28 correct to the nearest dollar.

Calculate the lower and upper bounds for the cost of making 450 chairs.

Answer lower bound $ ......................................

upper bound $ ...................................... [2]
5 Jiwan incorrectly wrote $\frac{1}{2} + \frac{1}{3} + \frac{1}{4} = 1 \frac{3}{9}$.

Show the correct working and write down the answer as a mixed number.

Answer $\ldots$ [3]

6 The force, $F$, between two magnets varies inversely as the square of the distance, $d$, between them.

$F = 150$ when $d = 2$.

Calculate $F$ when $d = 4$.

Answer $F = \ldots$ [3]
7 \[ \begin{pmatrix} 0 & 2 \\ -3 & 4 \end{pmatrix} \begin{pmatrix} a \\ b \end{pmatrix} = \begin{pmatrix} 8 \\ 25 \end{pmatrix} \]

Find the value of \( a \) and the value of \( b \).

Answer \( a = \) \[ \text{..................} \]  
\( \]  
\( b = \) \[ \text{..................} \] \[ 3 \]

8 A cruise ship travels at 22 knots.

[1 knot is 1.852 kilometres per hour.]

Convert this speed into metres per second.

Answer \( \) \[ \text{..................} \] m/s \[ 3 \]
9 A sequence is given by \( u_1 = \sqrt{1} \), \( u_2 = \sqrt{3} \), \( u_3 = \sqrt{5} \), \( u_4 = \sqrt{7} \), …

(a) Find a formula for \( u_n \), the \( n \)th term.

\[ \text{Answer (a)} \quad u_n = \]

(b) Find \( u_{29} \).

\[ \text{Answer (b)} \quad u_{29} = \]

10 Write as a single fraction in its simplest form.

\[ \frac{3}{x+10} - \frac{1}{x+4} \]

\[ \text{Answer} \]

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11 Find the values of $m$ and $n$.

(a) $2^m = 0.125$

Answer (a) $m =$ ........................................... [2]

(b) $2^{4n} \times 2^{2n} = 512$

Answer (b) $n =$ ........................................... [2]

12

A small car accelerates from 0 m/s to 40 m/s in 6 seconds and then travels at this constant speed. A large car accelerates from 0 m/s to 40 m/s in 10 seconds.

Calculate how much further the small car travels in the first 10 seconds.

Answer ........................................... m [4]
$AOC$ is a diameter of the circle, centre $O$.
$AT$ is a straight line that cuts the circle at $B$.
$PT$ is the tangent to the circle at $C$.
Angle $COB = 76^\circ$.
(a) Calculate angle $ATC$.

\[
\text{Answer} (a) \quad \text{Angle } ATC = \text{..........................} \quad [2]
\]

(b) $T$ is due north of $C$.
Calculate the bearing of $B$ from $C$.

\[
\text{Answer} (b) \quad \text{..........................} \quad [2]
\]
The region $R$ is bounded by three lines.

Write down the three inequalities which define the region $R$.

Answer

............... [4]
The points \(A(1, 2)\) and \(B(5, 5)\) are shown on the diagram.

(a) Work out the co-ordinates of the midpoint of \(AB\).

\[
\text{Answer} (a) \left( \begin{array}{c}
\text{\( \underline{\phantom{0000}} \)} \\
\text{\( \underline{\phantom{0000}} \)}
\end{array} \right) [1]
\]

(b) Write down the column vector \(\overrightarrow{AB}\).

\[
\text{Answer} (b) \overrightarrow{AB} = \left( \begin{array}{c}
\text{\( \underline{\phantom{0000}} \)} \\
\text{\( \underline{\phantom{0000}} \)}
\end{array} \right) [1]
\]

(c) Using a straight edge and compasses only, draw the locus of points which are equidistant from \(A\) and from \(B\). [2]
In a survey of 60 cars, the type of fuel that they use is recorded in the table below.

Each car only uses one type of fuel.

<table>
<thead>
<tr>
<th>Petrol</th>
<th>Diesel</th>
<th>Liquid Hydrogen</th>
<th>Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>12</td>
<td>2</td>
<td>6</td>
</tr>
</tbody>
</table>

(a) Write down the mode.

Answer(a) ............................................ [1]

(b) Olav drew a pie chart to illustrate these figures.

Calculate the angle of the sector for Diesel.

Answer(b) ............................................ [2]

(c) Calculate the probability that a car chosen at random uses Electricity.

Write your answer as a fraction in its simplest form.

Answer(c) ............................................ [2]
O is the origin, \( \overrightarrow{OA} = \mathbf{a} \), \( \overrightarrow{OC} = \mathbf{c} \) and \( \overrightarrow{CB} = 4\mathbf{a} \).

\( M \) is the midpoint of \( AB \).

(a) Find, in terms of \( \mathbf{a} \) and \( \mathbf{c} \), in their simplest form

(i) the vector \( \overrightarrow{AB} \),

\[ \text{Answer(a)(i)} \overrightarrow{AB} = \] [2]

(ii) the position vector of \( M \).

\[ \text{Answer(a)(ii)} \] [2]

(b) Mark the point \( D \) on the diagram where \( \overrightarrow{OD} = 3\mathbf{a} + \mathbf{c} \). [2]

18

\[ w = \frac{1}{\sqrt{LC}} \]

(a) Find \( w \) when \( L = 8 \times 10^{-3} \) and \( C = 2 \times 10^{-9} \).

Give your answer in standard form.

\[ \text{Answer(a)} w = \] [3]

(b) Rearrange the formula to make \( C \) the subject.

\[ \text{Answer(b)} C = \] [3]

Question 19 is printed on the next page.
(a) Using a straight edge and compasses only, construct the angle bisector of angle $ABC$. [2]

(b) Work out the equation of the line $BC$. [3]

(c) $ABC$ forms a right-angled isosceles triangle of area 6.5 cm$^2$.

Calculate the length of $AB$. [2]
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The total of the marks for this paper is 70.
1 Martha divides $240 between spending and saving in the ratio

\[ \text{spending : saving} = 7 : 8. \]

Calculate the amount Martha has for spending.

\[ \text{Answer} \$ \text{.......................................} \] [2]

2 From the list of numbers, find

(a) a prime number,

\[ \text{Answer(a) .......................................} \] [1]

(b) a cube number.

\[ \text{Answer(b) .......................................} \] [1]

3 Solve the simultaneous equations.

\[ \begin{align*}
    x + 5y &= 22 \\
    x + 3y &= 12
\end{align*} \]

\[ \text{Answer} x = \text{.......................................} \]

\[ \text{Answer} y = \text{.......................................} \] [2]
4 Find the value of \( \left( \frac{27}{8} \right)^\frac{4}{3} \).
Give your answer as an exact fraction.

Answer .............................. [2]

5 The population of a city is 128 000, correct to the nearest thousand.

(a) Write 128 000 in standard form.

Answer(a) .............................. [1]

(b) Write down the upper bound of the population.

Answer(b) .............................. [1]

6 Pedro invested $800 at a rate of 5% per year compound interest.
Calculate the total amount he has after 2 years.

Answer $ .............................. [2]

7 Show that \( 3^{-2} + 2^{-2} = \frac{13}{36} \).
Write down all the steps of your working.

Answer

[2]
8 Find the value of \( \frac{\sqrt[3]{7.1 - 1.89}}{10.4 + \sqrt{8.36}} \).

Answer .................................. [2]

9 In Vienna, the mid-day temperatures, in °C, are recorded during a week in December. This information is shown below.

\[-2 \quad 2 \quad 1 \quad -3 \quad -1 \quad -2 \quad 0\]

Calculate

(a) the difference between the highest temperature and the lowest temperature,

Answer(a) .................................. °C [1]

(b) the mean temperature.

Answer(b) .................................. °C [2]

10 Maria decides to increase her homework time of 8 hours per week by 15%.

Calculate her new homework time.
Give your answer in hours and minutes.

Answer ............. h ........... min [3]
11 Factorise completely.

\[ p^2x - 4q^2x \]

Answer ........................................... [3]

12 Alberto changes 800 Argentine pesos (ARS) into dollars ($) when the rate is \$1 = 3.8235 ARS.
He spends \$150 and changes the remaining dollars back into pesos when the rate is
\$1 = 3.8025 ARS.
Calculate the amount Alberto now has in pesos.

Answer .......................... ARS [3]

13 During a marathon race an athlete loses 2% of his mass.
At the end of the race his mass is 67.13 kg.
Calculate his mass before the race.

Answer ............................. kg [3]
The sphere of radius $r$ fits exactly inside the cylinder of radius $r$ and height $2r$. Calculate the percentage of the cylinder occupied by the sphere.

[The volume, $V$, of a sphere with radius $r$ is $V = \frac{4}{3}\pi r^3$.]

Answer $\ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \%$ [3]

15

$ap = px + c$

Write $p$ in terms of $a$, $c$ and $x$.

Answer $p = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots$ [3]
16 The time, \( t \), for a pendulum to swing varies directly as the square root of its length, \( l \). When \( l = 9 \), \( t = 6 \).

(a) Find a formula for \( t \) in terms of \( l \).

\[
Answer(a) \ t = \ ...................................... \quad [2]
\]

(b) Find \( t \) when \( l = 2.25 \).

\[
Answer(b) \ t = \ ...................................... \quad [1]
\]

17

In the Venn diagram, \( \mathcal{E} = \{ \text{students in a survey} \} \), \( R = \{ \text{students who like rugby} \} \) and \( F = \{ \text{students who like football} \} \).

\[
n(\mathcal{E}) = 20 \quad n(R \cup F) = 17 \quad n(R) = 13 \quad n(F) = 11
\]

(a) Find

(i) \( n(R \cap F) \),

\[
Answer(a)(i) \ ...................................... \quad [1]
\]

(ii) \( n(R' \cap F) \).

\[
Answer(a)(ii) \ ...................................... \quad [1]
\]

(b) A student who likes rugby is chosen at random.

Find the probability that this student also likes football.

\[
Answer(b) \ ...................................... \quad [1]
\]
18 Write as a single fraction, in its simplest form.

\[
\frac{1-x}{x} - \frac{2+x}{1-2x}
\]

Answer .................................. [4]

19

The diagram shows a sector \( AOB \) of a circle, centre \( O \), radius 9 cm with angle \( AOB = 50^\circ \).

Calculate the area of the segment shaded in the diagram.

Answer .................................. \( \text{cm}^2 \) [4]
20 (a) \( \mathbf{N} = \begin{pmatrix} 2 \\ 6 \end{pmatrix} \). The order of the matrix \( \mathbf{N} \) is \( 2 \times 1 \).

\( \mathbf{P} = (1 \ 3) \). The order of the matrix \( \mathbf{P} \) is \( 1 \times 2 \).

(i) Write down the order of the matrix \( \mathbf{NP} \).

\( \text{Answer(a)(i)} \) ........................................ [1]

(ii) Calculate \( \mathbf{PN} \).

\( \text{Answer(a)(ii)} \) ........................................ [1]

(b) \( \mathbf{M} = \begin{pmatrix} 2 & 3 \\ 2 & 4 \end{pmatrix} \).

Find \( \mathbf{M}^{-1} \), the inverse of \( \mathbf{M} \).

\( \text{Answer(b)} \) \( \mathbf{M}^{-1} = \) ........................................ [2]
The diagram shows 3 ships $A$, $B$ and $C$ at sea.

$AB = 5 \text{ km}, \ BC = 4.5 \text{ km} \text{ and } AC = 2.7 \text{ km}.$

(a) Calculate angle $ACB$.
Show all your working.

Answer (a) Angle $ACB = \boxed{ \text{ } }$ [4]

(b) The bearing of $A$ from $C$ is $220^\circ$.
Calculate the bearing of $B$ from $C$.

Answer (b) $\boxed{ \text{ } }$ [1]
A, B, C and D lie on a circle.
AC and BD intersect at X.

(a) Give a reason why angle BAX is equal to angle CDX.

Answer(a) ........................................................................................................................................... [1]

(b) AB = 4.40 cm, CD = 9.40 cm and BX = 3.84 cm.

(i) Calculate the length of CX.

Answer(b)(i) CX = ........................................... cm [2]

(ii) The area of triangle ABX is 5.41 cm².

Calculate the area of triangle CDX.

Answer(b)(ii) ........................................... cm² [2]

Question 23 is printed on the next page.
The diagram shows the speed-time graph for the first 15 **minutes** of a train journey.
The train accelerates for 5 minutes and then continues at a constant speed of 40 metres/second.

(a) Calculate the acceleration of the train during the first 5 minutes. Give your answer in m/s$^2$.

$$Answer(a) \quad \quad \quad \quad \quad \quad m/s^2$$ [2]

(b) Calculate the average speed for the first 15 minutes of the train journey. Give your answer in m/s.

$$Answer(b) \quad \quad \quad \quad \quad \quad m/s$$ [3]
Candidate Name

Centre Number

Candidate Number

Mathematics

Paper 4 (Extended)

October/November 2011

2 hours 30 minutes

Candidates answer on the Question Paper.

Additional Materials: Electronic calculator Geometrical instruments

Mathematical tables (optional) Tracing paper (optional)

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At the end of the examination, fasten all your work securely together.

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

The total of the marks for this paper is 130.

This document consists of 16 printed pages.
1 (a) Abdullah and Jasmine bought a car for $9000. Abdullah paid 45% of the $9000 and Jasmine paid the rest.

(i) How much did Jasmine pay towards the cost of the car?

*Answer (a)(i) $ .......................................................... [2]*

(ii) Write down the ratio of the payments Abdullah : Jasmine in its simplest form.

*Answer (a)(ii) ...................... : ...................... [1]*

(b) Last year it cost $2256 to run the car. Abdullah, Jasmine and their son Henri share this cost in the ratio 8 : 3 : 1. Calculate the amount each paid to run the car.

*Answer (b) Abdullah $ .................................................

Jasmine $ ..................................................

Henri $ .................................................. [3]

(c) (i) A new truck costs $15 000 and loses 23% of its value each year. Calculate the value of the truck after three years.

*Answer (c)(i) $ .................................................. [3]*

(ii) Calculate the overall percentage loss of the truck’s value after three years.

*Answer (c)(ii) .................................................. %[3]*
2 (a) Find the integer values for $x$ which satisfy the inequality $-3 < 2x - 1 \leq 6$.

Answer(a) ........................................... [3]

(b) Simplify $\frac{x^2 + 3x - 10}{x^2 - 25}$.

Answer(b) ........................................... [4]

c (i) Show that $\frac{5}{x - 3} + \frac{2}{x + 1} = 3$ can be simplified to $3x^2 - 13x - 8 = 0$.

Answer(c)(i)

(ii) Solve the equation $3x^2 - 13x - 8 = 0$.

Show all your working and give your answers correct to two decimal places.

Answer(c)(ii) $x = \ldots \ldots \ldots \ldots$ or $x = \ldots \ldots \ldots \ldots$ [4]
The table shows information about the heights of 120 girls in a swimming club.

<table>
<thead>
<tr>
<th>Height (h metres)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.3 &lt; h ≤ 1.4</td>
<td>4</td>
</tr>
<tr>
<td>1.4 &lt; h ≤ 1.5</td>
<td>13</td>
</tr>
<tr>
<td>1.5 &lt; h ≤ 1.6</td>
<td>33</td>
</tr>
<tr>
<td>1.6 &lt; h ≤ 1.7</td>
<td>45</td>
</tr>
<tr>
<td>1.7 &lt; h ≤ 1.8</td>
<td>19</td>
</tr>
<tr>
<td>1.8 &lt; h ≤ 1.9</td>
<td>6</td>
</tr>
</tbody>
</table>

(a) (i) Write down the modal class.

Answer(a)(i) ........................................ m[1]

(ii) Calculate an estimate of the mean height. Show all of your working.

Answer(a)(ii) ........................................ m[4]

(b) Girls from this swimming club are chosen at random to swim in a race.
Calculate the probability that

(i) the height of the first girl chosen is more than 1.8 metres,

Answer(b)(i) ........................................ [1]

(ii) the heights of both the first and second girl chosen are 1.8 metres or less.

Answer(b)(ii) ........................................ [3]
(c) (i) Complete the cumulative frequency table for the heights.

<table>
<thead>
<tr>
<th>Height ($h$ metres)</th>
<th>Cumulative frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>$h \leq 1.3$</td>
<td>0</td>
</tr>
<tr>
<td>$h \leq 1.4$</td>
<td>4</td>
</tr>
<tr>
<td>$h \leq 1.5$</td>
<td>17</td>
</tr>
<tr>
<td>$h \leq 1.6$</td>
<td>50</td>
</tr>
<tr>
<td>$h \leq 1.7$</td>
<td></td>
</tr>
<tr>
<td>$h \leq 1.8$</td>
<td>114</td>
</tr>
<tr>
<td>$h \leq 1.9$</td>
<td></td>
</tr>
</tbody>
</table>

(ii) Draw the cumulative frequency graph on the grid.

(d) Use your graph to find

(i) the median height,

\[ \text{Answer (d)(i)} \hspace{1cm} \text{m} \] [1]

(ii) the 30th percentile.

\[ \text{Answer (d)(ii)} \hspace{1cm} \text{m} \] [1]
The diagram shows a plastic cup in the shape of a cone with the end removed. The vertical height of the cone in the diagram is 20 cm. The height of the cup is 8 cm. The base of the cup has radius 2.7 cm.

(a) (i) Show that the radius, $r$, of the circular top of the cup is 4.5 cm.

Answer (a)(i)

(ii) Calculate the volume of water in the cup when it is full.

[The volume, $V$, of a cone with radius $r$ and height $h$ is $V = \frac{1}{3} \pi r^2 h$.]

Answer (a)(ii) \[ \text{cm}^3 \] [4]
(b) (i) Show that the slant height, $s$, of the cup is 8.2 cm.

Answer(b)(i)

(ii) Calculate the curved surface area of the outside of the cup.
[The curved surface area, $A$, of a cone with radius $r$ and slant height $l$ is $A = \pi rl$.]

Answer(b)(ii) ........................................... cm$^2$ [5]
5 (a) Complete the table for the function \( f(x) = \frac{x^3}{2} - 3x - 1 \).

| \( x \) | \(-3\) | \(-2\) | \(-1.5\) | \(-1\) | \(0\) | \(1\) | \(1.5\) | \(2\) | \(3\) | \(3.5\) |
|---|---|---|---|---|---|---|---|---|---|
| \( f(x) \) | \(-5.5\) | \(1.8\) | \(1.5\) | \(-3.5\) | \(-3.8\) | \(-3\) | \(9.9\) | 

(b) On the grid draw the graph of \( y = f(x) \) for \( -3 \leq x \leq 3.5 \).
(c) Use your graph to

(i) solve \( f(x) = 0.5 \),

\[
\text{Answer}(c)(i) x = \ldots \text{ or } x = \ldots \text{ or } x = \ldots \quad [3]
\]

(ii) find the inequalities for \( k \), so that \( f(x) = k \) has only 1 answer.

\[
\text{Answer}(c)(ii) \quad k < \ldots \quad k > \ldots \quad [2]
\]

(d) (i) On the same grid, draw the graph of \( y = 3x - 2 \) for \( -1 \leq x \leq 3.5 \). \[3\]

(ii) The equation \( \frac{x^3}{2} - 3x - 1 = 3x - 2 \) can be written in the form \( x^3 + ax + b = 0 \).

Find the values of \( a \) and \( b \).

\[
\text{Answer}(d)(ii) a = \ldots \quad \text{and } b = \ldots \quad [2]
\]

(iii) Use your graph to find the positive answers to \( \frac{x^3}{2} - 3x - 1 = 3x - 2 \) for \( -3 \leq x \leq 3.5 \).

\[
\text{Answer}(d)(iii) x = \ldots \text{ or } x = \ldots \quad [2]
\]
The quadrilateral \(ABCD\) represents an area of land. There is a straight road from \(A\) to \(C\).

\(AB = 79\) m, \(AD = 120\) m and \(CD = 95\) m.

Angle \(BCA = 26^\circ\) and angle \(CDA = 77^\circ\).

(a) Show that the length of the road, \(AC\), is 135 m correct to the nearest metre.

\[ \text{Answer (a)} \]

(b) Calculate the size of the obtuse angle \(ABC\).

\[ \text{Answer (b)} \text{ Angle } ABC = \text{.................................} \]
(c) A straight path is to be built from $B$ to the nearest point on the road $AC$.

Calculate the length of this path.

\[ \text{Answer (c)} \]

(d) Houses are to be built on the land in triangle $ACD$.
Each house needs at least $180 \text{ m}^2$ of land.

Calculate the maximum number of houses which can be built.
Show all of your working.

\[ \text{Answer (d)} \]
(a) Describe fully the single transformation which maps

(i) triangle $A$ onto triangle $B$,

$Answer(a)(i)$ .......................................................... [2]

(ii) triangle $A$ onto triangle $C$,

$Answer(a)(ii)$ .......................................................... [3]

(iii) triangle $A$ onto triangle $D$.

$Answer(a)(iii)$ .......................................................... [3]
(b) Draw the image of

(i) triangle $B$ after a translation of $\begin{pmatrix} -5 \\ 2 \end{pmatrix}$.

(ii) triangle $B$ after a transformation by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$.

(c) Describe fully the single transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$.

Answer (c) 

..........................................................................................................................................................................................

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..........................................................................................................................................................................................
Mr Chang hires $x$ large coaches and $y$ small coaches to take 300 students on a school trip. Large coaches can carry 50 students and small coaches 30 students. There is a maximum of 5 large coaches.

(a) Explain clearly how the following two inequalities satisfy these conditions.

(i) $x \leq 5$

(ii) $5x + 3y \geq 30$

Mr Chang also knows that $x + y \leq 10$.

(b) On the grid, show the information above by drawing three straight lines and shading the unwanted regions.
(c) A large coach costs $450 to hire and a small coach costs $350.

(i) Find the number of large coaches and the number of small coaches that would give the minimum hire cost for this school trip.

Answer (c)(i) Large coaches ..........................................
Small coaches .............................................. [2]

(ii) Calculate this minimum cost.

Answer (c)(ii) $ ........................................ [1]

9 (a) \(72 = 2 \times 2 \times 2 \times 3 \times 3\) written as a product of prime factors.

(i) Write the number 126 as a product of prime factors.

Answer (a)(i) 126 = ........................................ [2]

(ii) Find the value of the highest common factor of 72 and 126.

Answer (a)(ii) ........................................ [1]

(iii) Find the value of the lowest common multiple of 72 and 126.

Answer (a)(iii) ........................................ [2]

The rest of question 9 is printed on the next page.
(b) John wants to estimate the value of $\pi$.
He measures the circumference of a circular pizza as 105 cm and its diameter as 34 cm, both correct to the nearest centimetre.

Calculate the lower bound of his estimate of the value of $\pi$.
Give your answer correct to 3 decimal places.

Answer(b) ................................ [4]

(c) The volume of a cylindrical can is 550 cm$^3$, correct to the nearest 10 cm$^3$.
The height of the can is 12 cm correct to the nearest centimetre.

Calculate the upper bound of the radius of the can.
Give your answer correct to 3 decimal places.

Answer(c) ................................ cm [5]
READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO NOT WRITE IN ANY BARCODES.

Answer all questions.
If working is needed for any question it must be shown below that question.
Electronic calculators should be used.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For π use either your calculator value or 3.142.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 130.
Children go to camp on holiday.

(a) Fatima buys bananas and apples for the camp.

(i) Bananas cost $0.85 per kilogram.

Fatima buys 20kg of bananas and receives a discount of 14%.

How much does she spend on bananas?

\[ \text{Answer (a)(i)} \]

(ii) Fatima spends $16.40 on apples after a discount of 18%.

Calculate the original price of the apples.

\[ \text{Answer (a)(ii)} \]

(iii) The ratio number of bananas : number of apples = 4 : 5.

There are 108 bananas.

Calculate the number of apples.

\[ \text{Answer (a)(iii)} \]
(b) The cost to hire a tent consists of two parts.

\[ \$c \] + \[ \$d \text{ per day} \]

The total cost for 4 days is $27.10 and for 7 days is $34.30.

Write down two equations in \( c \) and \( d \) and solve them.

\[ \text{Answer(b)} \ c = \text{.........................} \]
\[ \text{d} = \text{.........................} \] [4]

(c) The children travel 270 km to the camp, leaving at 07 43 and arriving at 15 13.

Calculate their average speed in km/h.

\[ \text{Answer(c)} \text{.........................} \text{ km/h} \] [3]

(d) Two years ago $540 was put in a savings account to pay for the holiday.

The account paid compound interest at a rate of 6% per year.

How much is in the account now?

\[ \text{Answer(d)} \$ \text{.........................} \] [2]
2

\[ f(x) = 4x - 2 \]
\[ g(x) = \frac{2}{x} + 1 \]
\[ h(x) = x^2 + 3 \]

(a) (i) Find the value of \( hf(2) \).

Answer (a)(i) ........................................... [2]

(ii) Write \( fg(x) \) in its simplest form.

Answer (a)(ii) \( fg(x) = \) ........................................... [2]

(b) Solve \( g(x) = 0.2 \).

Answer (b) \( x = \) ........................................... [2]

(c) Find the value of \( gg(3) \).

Answer (c) ........................................... [2]
(d)  (i) Show that \( f(x) = g(x) \) can be written as \( 4x^2 - 3x - 2 = 0 \).

Answer (d)(i)

(ii) Solve the equation \( 4x^2 - 3x - 2 = 0 \).

Show all your working and give your answers correct to 2 decimal places.

Answer (d)(ii) \( x = \ldots \) or \( x = \ldots \) [4]
Triangles $T$ and $A$ are drawn on the grid above.

(a) Describe fully the single transformation that maps triangle $T$ onto triangle $A$.

Answer(a) ................................................................................................................................................ [2]

(b) (i) Draw the image of triangle $T$ after a rotation of $90^\circ$ anticlockwise about the point $(0,0)$.

Label the image $B$. .................................................. [2]

(ii) Draw the image of triangle $T$ after a reflection in the line $x + y = 0$.

Label the image $C$. ............................................ [2]

(iii) Draw the image of triangle $T$ after an enlargement with centre $(4, 5)$ and scale factor 1.5.

Label the image $D$. ............................................ [2]
(c) (i) Triangle $T$ has its vertices at co-ordinates $(2, 1)$, $(6, 1)$ and $(6, 3)$.

Transform triangle $T$ by the matrix $\begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$.

Draw this image on the grid and label it $E$.

(ii) Describe fully the single transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 1 & 1 \end{pmatrix}$.

Answer (c)(ii) .................................................................................................................................................. [3]

(d) Write down the matrix that transforms triangle $B$ onto triangle $T$.

Answer (d) $\begin{pmatrix} \quad \quad \quad \\ \quad \quad \quad \end{pmatrix}$ [2]
4 Boris has a recipe which makes 16 biscuits.

The ingredients are

- 160 g flour,
- 160 g sugar,
- 240 g butter,
- 200 g oatmeal.

(a) Boris has only 350 grams of oatmeal but plenty of the other ingredients.

(i) How many biscuits can he make?

Answer(a)(i) ........................................... [2]

(ii) How many grams of butter does he need to make this number of biscuits?

Answer(a)(ii) ........................................... g [2]

(b) The ingredients are mixed together to make dough.

This dough is made into a sphere of volume 1080 cm$^3$.

Calculate the radius of this sphere.

[The volume, \( V \), of a sphere of radius \( r \) is \( V = \frac{4}{3} \pi r^3 \).]

Answer(b) ........................................... cm [3]
The 1080 cm$^3$ of dough is then rolled out to form a cuboid $20$ cm $\times$ $30$ cm $\times$ $1.8$ cm.

Boris cuts out circular biscuits of diameter $5$ cm.

(i) How many whole biscuits can he cut from this cuboid?

$Answer(c)(i)$ ........................................ [1]

(ii) Calculate the volume of dough left over.

$Answer(c)(ii)$ ........................................ cm$^3$ [3]
5 (a) The times, $t$ seconds, for 200 people to solve a problem are shown in the table.

<table>
<thead>
<tr>
<th>Time ($t$ seconds)</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0 &lt; t \leq 20$</td>
<td>6</td>
</tr>
<tr>
<td>$20 &lt; t \leq 40$</td>
<td>12</td>
</tr>
<tr>
<td>$40 &lt; t \leq 50$</td>
<td>20</td>
</tr>
<tr>
<td>$50 &lt; t \leq 60$</td>
<td>37</td>
</tr>
<tr>
<td>$60 &lt; t \leq 70$</td>
<td>42</td>
</tr>
<tr>
<td>$70 &lt; t \leq 80$</td>
<td>50</td>
</tr>
<tr>
<td>$80 &lt; t \leq 90$</td>
<td>28</td>
</tr>
<tr>
<td>$90 &lt; t \leq 100$</td>
<td>5</td>
</tr>
</tbody>
</table>

Calculate an estimate of the mean time.

Answer (a) ........................................... s [4]

(b) (i) Complete the cumulative frequency table for this data.

<table>
<thead>
<tr>
<th>Time ($t$ seconds)</th>
<th>$t \leq 20$</th>
<th>$t \leq 40$</th>
<th>$t \leq 50$</th>
<th>$t \leq 60$</th>
<th>$t \leq 70$</th>
<th>$t \leq 80$</th>
<th>$t \leq 90$</th>
<th>$t \leq 100$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Frequency</td>
<td>6</td>
<td>18</td>
<td>38</td>
<td>167</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[2]

(ii) Draw the cumulative frequency graph on the grid opposite to show this data. [4]

(c) Use your cumulative frequency graph to find

(i) the median time,

Answer (c)(i) ........................................... s [1]

(ii) the lower quartile,

Answer (c)(ii) ........................................... s [1]

(iii) the inter-quartile range,

Answer (c)(iii) ........................................... s [1]

(iv) how many people took between 65 and 75 seconds to solve the problem,

Answer (c)(iv) ........................................... [1]

(v) how many people took longer than 45 seconds to solve the problem.

Answer (c)(v) ........................................... [2]
A solid cone has diameter 9 cm, slant height 10 cm and vertical height $h$ cm.

(a) (i) Calculate the curved surface area of the cone.

[The curved surface area, $A$, of a cone, radius $r$ and slant height $l$ is $A = \pi rl$.]

Answer(a)(i) \[ \text{cm}^2 \] [2]

(ii) Calculate the value of $h$, the vertical height of the cone.

Answer(a)(ii) $h = \text{cm}$ [3]

(b) Sasha cuts off the top of the cone, making a smaller cone with diameter 3 cm. This cone is similar to the original cone.

(i) Calculate the **vertical** height of this small cone.

Answer(b)(i) \[ \text{cm} \] [2]
(ii) Calculate the curved surface area of this small cone.

\[ \text{Answer (b)(ii)} \quad \frac{1}{2} \pi \times 9 \times 12 \quad \text{cm}^2 \quad [2] \]

(c) The shaded solid from part (b) is joined to a solid cylinder with diameter 9 cm and height 12 cm. Calculate the total surface area of the whole solid.

\[ \text{Answer (c)} \quad \text{cm}^2 \quad [5] \]
The diagram shows the accurate graph of \( y = f(x) \) where \( f(x) = \frac{1}{x} + x^2 \) for \( 0 < x \leq 3 \).
(a) Complete the table for \( f(x) = \frac{1}{x} + x^2 \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>(-3)</th>
<th>(-2)</th>
<th>(-1)</th>
<th>(-0.5)</th>
<th>(-0.3)</th>
<th>(-0.1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>3.5</td>
<td>0</td>
<td>-1.8</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) On the grid, draw the graph of \( y = f(x) \) for \(-3 \leq x < 0\).

(c) By drawing a tangent, work out an estimate of the gradient of the graph where \( x = 2 \).

Answer(c) ........................................... [3]

(d) Write down the inequality satisfied by \( k \) when \( f(x) = k \) has three answers.

Answer(d) ........................................... [1]

(e) (i) Draw the line \( y = 1 - x \) on the grid for \(-3 \leq x \leq 3\).

(ii) Use your graphs to solve the equation \( 1 - x = \frac{1}{x} + x^2 \).

Answer(e)(ii) \( x = ........................................... \) [1]

(f) (i) Rearrange \( x^3 - x^2 - 2x + 1 = 0 \) into the form \( \frac{1}{x} + x^2 = ax + b \), where \( a \) and \( b \) are integers.

Answer(f)(i)

(ii) Write down the equation of the line that could be drawn on the graph to solve \( x^3 - x^2 - 2x + 1 = 0 \).

Answer(f)(ii) \( y = ........................................... \) [1]
Parvatti has a piece of canvas $ABCD$ in the shape of an irregular quadrilateral.

$AB = 3 \text{ m}, AC = 5 \text{ m}$ and angle $BAC = 45^\circ$.

(a) (i) Calculate the length of $BC$ and show that it rounds to 3.58 m, correct to 2 decimal places.

You must show all your working.

Answer (a)(i)

(ii) Calculate angle $BCA$.

Answer (a)(ii) Angle $BCA =$ ......................................... [3]
(b) \( AC = CD \) and angle \( CDA = 52^\circ \).

(i) Find angle \( DCA \).

\[ \text{Answer(b)(i)} \text{ Angle } DCA = \text{ .........................} \quad [1] \]

(ii) Calculate the area of the canvas.

\[ \text{Answer(b)(ii)} \text{ ......................... } \text{ m}^2 \quad [3] \]

(c) Parvatti uses the canvas to give some shade.

She attaches corners \( A \) and \( D \) to the top of vertical poles, \( AP \) and \( DQ \), each of height 2 m.

Corners \( B \) and \( C \) are pegged to the horizontal ground.

\( AB \) is a straight line and angle \( BPA = 90^\circ \).

Calculate angle \( PAB \).

\[ \text{Answer(c)} \text{ Angle } PAB = \text{ .........................} \quad [2] \]
9 (a) Emile lost 2 blue buttons from his shirt.

A bag of spare buttons contains 6 white buttons and 2 blue buttons.

Emile takes 3 buttons out of the bag at random without replacement.

Calculate the probability that

(i) all 3 buttons are white,

Answer(a)(i) .................................................. [3]

(ii) exactly one of the 3 buttons is blue.

Answer(a)(ii) .................................................. [3]
(b) There are 25 buttons in another bag.

This bag contains \( x \) blue buttons.

Two buttons are taken at random without replacement.

The probability that they are both blue is \( \frac{7}{100} \).

(i) Show that \( x^2 - x - 42 = 0 \).

Answer (b)(i)

(ii) Factorise \( x^2 - x - 42 \).

Answer (b)(ii)

(iii) Solve the equation \( x^2 - x - 42 = 0 \).

Answer (b)(iii) \( x = \) \( \ldots \) or \( x = \) \( \ldots \)

(iv) Write down the number of buttons in the bag which are not blue.

Answer (b)(iv) \( \ldots \)
A rectangular tank measures 1.2 m by 0.8 m by 0.5 m.

(a) Water flows from the full tank into a cylinder at a rate of 0.3 \( m^3/\text{min} \).

Calculate the time it takes for the full tank to empty.
Give your answer in minutes and seconds.

Answer (a) \( ............... \) min \( ............... \) s [3]
(b) The radius of the cylinder is 0.4 m.

Calculate the depth of water, \( d \), when all the water from the rectangular tank is in the cylinder.

\[ \text{Answer (b)} \quad d = \text{......................... m} \quad [3] \]

(c) The cylinder has a height of 1.2 m and is open at the top. The inside surface is painted at a cost of $2.30 per m\(^2\).

Calculate the cost of painting the inside surface.

\[ \text{Answer (c)} \quad $ \text{.........................} \quad [4] \]
2  (a) Complete the table of values for $y = 2^x$.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$-2$</th>
<th>$-1$</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>0.25</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

(b) On the grid, draw the graph of $y = 2^x$ for $-2 \leq x \leq 3$.

![Graph of $y = 2^x$ for $-2 \leq x \leq 3$.]
(c) (i) On the grid, draw the straight line which passes through the points (0, 2) and (3, 8). [1]

(ii) The equation of this line is $y = mx + 2$.

Show that the value of $m$ is 2.

$Answer(c)(ii)$

(iii) One answer to the equation $2^x = 2x + 2$ is $x = 3$.

Use your graph to find the other answer.

$Answer(c)(iii) \quad x = \quad \text{.................................} \quad [1]$  

(d) Draw the tangent to the curve at the point where $x = 1$.

Use this tangent to calculate an estimate of the gradient of $y = 2^x$ when $x = 1$.

$Answer(d) \quad \text{.................................} \quad [3]$
ABCD is a quadrilateral with angle BAD = 40°. AB is extended to E and angle EBC = 30°. AB = AD and BD = BC.

(i) Calculate angle BCD.

Answer(a)(i) Angle BCD = ........................................... [3]

(ii) Give a reason why DC is not parallel to AE.

Answer(a)(ii) ........................................................................................................................................... [1]

(b) A regular polygon has \( n \) sides.

Each exterior angle is \( \frac{5n}{2} \) degrees.

Find the value of \( n \).

Answer(b) \( n = \) ........................................... [3]
The diagram shows a circle centre $O$.
$A$, $B$ and $C$ are points on the circumference.
$OC$ is parallel to $AB$.
Angle $OCA = 25^\circ$.

Calculate angle $OBC$. 

\[
\text{Answer (c) Angle } OBC = \ldots \ldots \ldots \ldots [3]
\]
(a) Draw the reflection of shape $P$ in the line $y = x$. [2]

(b) Draw the translation of shape $P$ by the vector $\begin{pmatrix} -2 \\ 1 \end{pmatrix}$. [2]

(c) (i) Describe fully the single transformation that maps shape $P$ onto shape $W$.

Answer(c)(i) .................................................................................................................... [3]

(ii) Find the 2 by 2 matrix which represents this transformation.

Answer(c)(ii) $\begin{pmatrix} \left( \right) \end{pmatrix}$ [2]

(d) Describe fully the single transformation represented by the matrix $\begin{pmatrix} 1 & 0 \\ 0 & 2 \end{pmatrix}$.

Answer(d) ................................................................................................................................... [3]
5 (a) The cost of a bottle of juice is 5 cents more than the cost of a bottle of water.
Mohini buys 3 bottles of water and 6 bottles of juice.
The total cost is $5.25.

Find the cost of a bottle of water.
Give your answer in cents.

Answer (a) ..................................... cents [4]

(b) The cost of a biscuit is $x$ cents.
The cost of a cake is $(x + 3)$ cents.
The number of biscuits Roshni can buy for 72 cents is 2 more than the number of cakes she can buy for 72 cents.

(i) Show that $x^2 + 3x - 108 = 0$.

Answer (b)(i) 

(ii) Solve the equation $x^2 + 3x - 108 = 0$.

Answer (b)(ii) $x =$ ................. or $x =$ ................. [3]

(iii) Find the total cost of 2 biscuits and 1 cake.

Answer (b)(iii) ..................................... cents [1]
The diagram shows a triangular prism of length 12 cm.

The rectangle $ABCD$ is horizontal and the rectangle $DCPQ$ is vertical.

The cross-section is triangle $PBC$ in which angle $BCP = 90^\circ$, $BC = 4$ cm and $CP = 3$ cm.

(a) (i) Calculate the length of $AP$.

$Answer(a)(i)$ \[ AP = \] \[\text{cm} \] [3]

(ii) Calculate the angle of elevation of $P$ from $A$.

$Answer(a)(ii)$ \[ \text{ } \] [2]
(b) (i) Calculate angle $PBC$.

Answer (b)(i) Angle $PBC =$ ........................................... [2]

(ii) $X$ is on $BP$ so that angle $BXC = 120°$.

Calculate the length of $XC$.

Answer (b)(ii) $XC =$ ............................................... cm [3]
The times, \( t \) minutes, taken for 200 students to cycle one kilometre are shown in the table.

<table>
<thead>
<tr>
<th>Time (( t ) minutes)</th>
<th>( 0 &lt; t \leq 2 )</th>
<th>( 2 &lt; t \leq 3 )</th>
<th>( 3 &lt; t \leq 4 )</th>
<th>( 4 &lt; t \leq 8 )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>24</td>
<td>68</td>
<td>72</td>
<td>36</td>
</tr>
</tbody>
</table>

(a) Write down the class interval that contains the median.

\[ Answer(a) \]

(b) Calculate an estimate of the mean.
Show all your working.

\[ Answer(b) \]
(c) (i) Use the information in the table opposite to complete the cumulative frequency table.

<table>
<thead>
<tr>
<th>Time (t minutes)</th>
<th>t ≤ 2</th>
<th>t ≤ 3</th>
<th>t ≤ 4</th>
<th>t ≤ 8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative frequency</td>
<td>24</td>
<td></td>
<td></td>
<td>200</td>
</tr>
</tbody>
</table>

(ii) On the grid, draw a cumulative frequency diagram.

(iii) Use your diagram to find the median, the lower quartile and the inter-quartile range.

*Answer (c)(iii)* Median = ..................... min

Lower quartile = ..................... min

Inter-quartile range = ..................... min [3]
8 \[ f(x) = x^2 + x - 1 \quad g(x) = 1 - 2x \quad h(x) = 3^x \]

(a) Find the value of \( h(g(-2)) \).

\[ \text{Answer(a)} \]  

(b) Find \( g^{-1}(x) \).

\[ \text{Answer(b)} \quad g^{-1}(x) = \]  

(c) Solve the equation \( f(x) = 0 \).

Show all your working and give your answers correct to 2 decimal places.

\[ \text{Answer(c)} \quad x = \ldots \quad \text{or} \quad x = \ldots \]  

(d) Find \( fg(x) \).

Give your answer in its simplest form.

\[ \text{Answer(d)} \quad fg(x) = \]  

(e) Solve the equation \( h^{-1}(x) = 2 \).

\[ \text{Answer(e)} \quad x = \]
The diagram shows two sets of cards.

(a) One card is chosen at random from Set A and replaced.

(i) Write down the probability that the card chosen shows the letter M.

\[ \text{Answer(a)(i)} \]

(ii) If this is carried out 100 times, write down the expected number of times the card chosen shows the letter M.

\[ \text{Answer(a)(ii)} \]

(b) Two cards are chosen at random, without replacement, from Set A.

Find the probability that both cards show the letter S.

\[ \text{Answer(b)} \]

(c) One card is chosen at random from Set A and one card is chosen at random from Set B.

Find the probability that exactly one of the two cards shows the letter U.

\[ \text{Answer(c)} \]

(d) A card is chosen at random, without replacement, from Set B until the letter shown is either I or U.

Find the probability that this does not happen until the 4th card is chosen.

\[ \text{Answer(d)} \]
10 Hassan stores books in large boxes and small boxes. Each large box holds 20 books and each small box holds 10 books. He has $x$ large boxes and $y$ small boxes.

(a) Hassan must store at least 200 books.

Show that $2x + y \geq 20$.

Answer (a) [1]

(b) Hassan must not use more than 15 boxes. He must use at least 3 small boxes. The number of small boxes must be less than or equal to the number of large boxes.

Write down three inequalities to show this information.

Answer (b) [3]

(c) On the grid, show the information in part (a) and part (b) by drawing four straight lines and shading the unwanted regions.

[6]
(d) A large box costs $5 and a small box costs $2.

(i) Find the least possible total cost of the boxes.

\[ \text{Answer (d)(i)} \quad \text{\$ } \] \[ \text{[1]} \]

(ii) Find the number of large boxes and the number of small boxes which give this least possible cost.

\[ \text{Answer (d)(ii)} \quad \text{Number of large boxes} = \] \[ \text{[1]} \]
\[ \text{Number of small boxes} = \] \[ \text{[2]} \]

Question 11 is printed on the next page.
The points $P$ and $Q$ have co-ordinates $(-3, 1)$ and $(5, 2)$.

(i) Write $\overrightarrow{PQ}$ as a column vector.

(ii) $\overrightarrow{QR} = 2 \begin{pmatrix} -1 \\ 1 \end{pmatrix}$

Mark the point $R$ on the grid.

(iii) Write down the position vector of the point $P$. 

Answer (a) (i) $\overrightarrow{PQ} = \begin{pmatrix} \text{ } \\ \text{ } \end{pmatrix}$ [1]

(ii) $\overrightarrow{QR} = 2 \begin{pmatrix} -1 \\ 1 \end{pmatrix}$ [1]

(iii) $\begin{pmatrix} \text{ } \\ \text{ } \end{pmatrix}$ [1]
In the diagram, \( \overrightarrow{OU} = \mathbf{u} \) and \( \overrightarrow{OV} = \mathbf{v} \).

K is on \( UV \) so that \( \overrightarrow{UK} = \frac{2}{3} \overrightarrow{UV} \) and L is on \( OU \) so that \( \overrightarrow{OL} = \frac{3}{4} \overrightarrow{OU} \).

M is the midpoint of \( KL \).

Find the following in terms of \( \mathbf{u} \) and \( \mathbf{v} \), giving your answers in their simplest form.

(i) \( \overrightarrow{LK} \)

Answer (b)(i) \( \overrightarrow{LK} = \) .................................. [4]

(ii) \( \overrightarrow{OM} \)

Answer (b)(ii) \( \overrightarrow{OM} = \) .................................. [2]

Question 12 is printed on the next page.
12 (a) The $n$th term of a sequence is $n(n+1)$.

(i) Write the two missing terms in the spaces. 2, 6, ....... , 20, ....... [2]

(ii) Write down an expression in terms of $n$ for the $(n+1)$th term.

Answer(a)(ii) ____________________________ [1]

(iii) The difference between the $n$th term and the $(n+1)$th term is $pn + q$.

Find the values of $p$ and $q$.

Answer(a)(iii) $p =$ ____________________________

$q =$ ____________________________ [2]

(iv) Find the positions of the two consecutive terms which have a difference of 140.

Answer(a)(iv) ......... and ......... [2]

(b) A sequence $u_1, u_2, u_3, u_4, ............$ is given by the following rules.

$u_1 = 2,$ $u_2 = 3$ and $u_n = 2u_{n-2} + u_{n-1}$ for $n \geq 3$.

For example, the third term is $u_3$ and $u_3 = 2u_1 + u_2 = 2 \times 2 + 3 = 7$.

So, the sequence is 2, 3, 7, $u_4$, $u_5$, .......

(i) Show that $u_4 = 13$.

Answer(b)(i) ____________________________ [1]

(ii) Find the value of $u_5$.

Answer(b)(ii) $u_5 =$ ____________________________ [1]

(iii) Two consecutive terms of the sequence are 3413 and 6827.

Find the term before and the term after these two given terms.

Answer(b)(iii) ____________________________ , 3413, 6827, ____________________________ [2]
1. A concert hall has 1540 seats. Calculate the number of people in the hall when 55% of the seats are occupied.

Answer: ........................................... [1]

2. Shade the required region on each Venn diagram.

3. Calculate $81^{0.25} \div 4^{-2}$.

Answer: ........................................... [2]

4. (a) Find $m$ when $4^m \times 4^2 = 4^{12}$.

Answer (a) $m =$ ........................................... [1]

(b) Find $p$ when $6^p \div 6^5 = \sqrt{6}$.

Answer (b) $p =$ ........................................... [1]
5 A hummingbird beats its wings 24 times per second.

(a) Calculate the number of times the hummingbird beats its wings in one hour.

\[
\text{Answer (a)} \quad \text{[1]}
\]

(b) Write your answer to part (a) in standard form.

\[
\text{Answer (b)} \quad \text{[1]}
\]

6

A company makes solid chocolate eggs and their shapes are mathematically similar. The diagram shows eggs of height 2 cm and 6 cm. The mass of the small egg is 4 g.

Calculate the mass of the large egg.

\[
\text{Answer} \quad \text{[2]}
\]

7 Find the length of the straight line from \(Q (−8, 1)\) to \(R (4, 6)\).

\[
\text{Answer } QR = \quad \text{[3]}
\]
8 Calculate the radius of a sphere with volume 1260 cm³.

[The volume, \( V \), of a sphere with radius \( r \) is \( V = \frac{4}{3} \pi r^3 \).]

\[ \text{Answer} \quad \ldots \ldots \ldots \quad \text{cm} \quad [3] \]

9

\( AB \) is parallel to \( CD \).

Calculate the value of \( x \).

\[ \text{Answer} \quad x = \quad \ldots \ldots \ldots \quad [3] \]

10 Solve the simultaneous equations.

\[
\begin{align*}
3x + y &= 30 \\
2x - 3y &= 53
\end{align*}
\]

\[ \text{Answer} \quad x = \quad \ldots \ldots \ldots \quad [3] \]

\[ y = \quad \ldots \ldots \ldots \quad [3] \]
A rectangular photograph measures 23.3 cm by 19.7 cm, each correct to 1 decimal place. Calculate the lower bound for

(a) the perimeter,

Answer(a) .................................. cm [2]

(b) the area.

Answer(b) .................................. cm² [1]

A train leaves Barcelona at 21 28 and takes 10 hours and 33 minutes to reach Paris.

(a) Calculate the time the next day when the train arrives in Paris.

Answer(a) .................................. [1]

(b) The distance from Barcelona to Paris is 827 km.

Calculate the average speed of the train in kilometres per hour.

Answer(b) ......................... km/h [3]
13 The scale on a map is 1: 20 000.

(a) Calculate the actual distance between two points which are 2.7 cm apart on the map. Give your answer in kilometres.

Answer (a) ................................ km [2]

(b) A field has an area of 64 400 m$^2$. Calculate the area of the field on the map in cm$^2$.

Answer (b) ................................ cm$^2$ [2]

14 Solve the equation $2x^2 + 3x - 6 = 0$.
Show all your working and give your answers correct to 2 decimal places.

Answer $x = \ldots$ or $x = \ldots$ [4]
A teacher asks 36 students which musical instruments they play.

\[ P = \{ \text{students who play the piano} \} \]
\[ G = \{ \text{students who play the guitar} \} \]
\[ D = \{ \text{students who play the drums} \} \]

The Venn diagram shows the results.

(a) Find the value of \( x \).

Answer (a) \( x = \) .............................................. [1]

(b) A student is chosen at random.

Find the probability that this student

(i) plays the drums but not the guitar,

Answer (b)(i) .............................................. [1]

(ii) plays only 2 different instruments.

Answer (b)(ii) .............................................. [1]

(c) A student is chosen at random from those who play the guitar.

Find the probability that this student plays no other instrument.

Answer(c) .............................................. [1]
The diagram shows a square of side $k$ cm.

The circle inside the square touches all four sides of the square.

(a) The shaded area is $A$ cm$^2$.

Show that $4A = 4k^2 - \pi k^2$.

*Answer (a)*

(b) Make $k$ the subject of the formula $4A = 4k^2 - \pi k^2$.

*Answer (b) $k =$ ...........................................
$A$, $B$ and $C$ are points on a circle, centre $O$.
$TA$ is a tangent to the circle at $A$ and $OBT$ is a straight line.
$AC$ is a diameter and angle $OTA = 24^\circ$.

Calculate

(a) angle $AOT$,

\[
Answer(a) \text{ Angle } AOT = \quad \quad \quad \quad \quad \quad \quad [2]
\]

(b) angle $ACB$,

\[
Answer(b) \text{ Angle } ACB = \quad \quad \quad \quad \quad [1]
\]

(c) angle $ABT$.

\[
Answer(c) \text{ Angle } ABT = \quad \quad \quad \quad \quad [2]
\]
In the diagram, $PQS$, $PMR$, $MXS$ and $QXR$ are straight lines.

$PQ = 2\ QS.$
$M$ is the midpoint of $PR$.
$QX : XR = 1 : 3.$

$\overrightarrow{PQ} = q$ and $\overrightarrow{PR} = r.$

(a) Find, in terms of $q$ and $r$,

(i) $\overrightarrow{RQ}$,

Answer (a)(i) $\overrightarrow{RQ} =$ ...........................................    [1]

(ii) $\overrightarrow{MS}$.

Answer (a)(ii) $\overrightarrow{MS} =$ ...........................................    [1]

(b) By finding $\overrightarrow{MX}$, show that $X$ is the midpoint of $MS$.

Answer (b)
The diagram shows the speed-time graph of a train journey between two stations. The train accelerates for two minutes, travels at a constant maximum speed, then slows to a stop.

(a) Write down the number of **seconds** that the train travels at its constant maximum speed.

**Answer(a)** ........................................... s [1]

(b) Calculate the distance between the two stations **in metres**.

**Answer(b)** ........................................... m[3]

(c) Find the acceleration of the train in the **first two minutes**.
    Give your answer in m/s².

**Answer(c)** ........................................... m/s² [2]

Question 20 is printed on the next page.
20  \( f(x) = x^3 \) \( g(x) = 2x - 3 \)

(a) Find

(i) \( g(6) \).

\[ \text{Answer(a)(i)} \] \[ \text{[1]} \]

(ii) \( f(2x) \).

\[ \text{Answer(a)(ii)} \] \[ \text{[1]} \]

(b) Solve \( fg(x) = 125 \).

\[ \text{Answer(b)} x = \] \[ \text{[3]} \]

(c) Find the inverse function \( g^{-1}(x) \).

\[ \text{Answer(c)} g^{-1}(x) = \] \[ \text{[2]} \]
1  In the right-angled triangle $ABC$, $\cos C = \frac{4}{5}$. Find angle $A$.

\[ \text{Answer} \quad \angle A = \quad \text{.........................} \quad [2] \]

2  Which of the following numbers are irrational?

\[ \frac{2}{3}, \quad \sqrt{36}, \quad \sqrt{3} + \sqrt{6}, \quad \pi, \quad 0.75, \quad 48\%, \quad \frac{1}{8^3} \]

\[ \text{Answer} \quad \text{.........................} \quad [2] \]

3  Show that \[ \frac{5}{9} \div \frac{7}{9} = \frac{7}{8}. \]

Write down all the steps in your working.

\[ \text{Answer} \]

[2]
4 \[
\frac{3}{5} < p < \frac{2}{3}
\]

Which of the following could be a value of \( p \)?

\[
\frac{16}{27} \quad 0.67 \quad 60\% \quad (0.8)^2 \quad \sqrt{\frac{4}{9}}
\]

Answer \begin{equation*} \end{equation*} [2]

5 A meal on a boat costs 6 euros (€) or 11.5 Brunei dollars ($).

In which currency does the meal cost less, on a day when the exchange rate is €1 = $1.9037? Write down all the steps in your working.

Answer \begin{equation*} \end{equation*} [2]

6 Use your calculator to find the value of \( 2^{\sqrt{3}} \).

Give your answer correct to 4 significant figures.

Answer \begin{equation*} \end{equation*} [2]
7 Solve the equation \( 4x + 6 \times 10^3 = 8 \times 10^4 \).
Give your answer in standard form.

\[ \text{Answer } x = \text{..........................} \quad [3] \]

8 \( p \) varies directly as the square root of \( q \).
\( p = 8 \) when \( q = 25 \).
Find \( p \) when \( q = 100 \).

\[ \text{Answer } p = \text{..........................} \quad [3] \]

9 Ashraf takes 1500 steps to walk \( d \) metres from his home to the station.
Each step is 90 centimetres correct to the nearest 10 cm.
Find the lower bound and the upper bound for \( d \).

\[ \text{Answer } \ldots \ldots \ldots \ll d < \ldots \ldots \ldots \quad [3] \]
10  The table shows the opening and closing times of a café.

<table>
<thead>
<tr>
<th></th>
<th>Mon</th>
<th>Tue</th>
<th>Wed</th>
<th>Thu</th>
<th>Fri</th>
<th>Sat</th>
<th>Sun</th>
</tr>
</thead>
<tbody>
<tr>
<td>Opening time</td>
<td>0600</td>
<td>0600</td>
<td>0600</td>
<td>0600</td>
<td>(a)</td>
<td>0800</td>
<td></td>
</tr>
<tr>
<td>Closing time</td>
<td>2200</td>
<td>2200</td>
<td>2200</td>
<td>2200</td>
<td>2200</td>
<td>2200</td>
<td>1300</td>
</tr>
</tbody>
</table>

(a) The café is open for a total of 100 hours each week.
Work out the opening time on Saturday.

Answer(a) .................................. [2]

(b) The owner decides to close the café at a later time on Sunday. This increases the **total** number of hours the café is open by 4%.
Work out the new closing time on Sunday.

Answer(b) .................................. [1]

11 Rearrange the formula \( c = \frac{4}{a - b} \) to make \( a \) the subject.

Answer \( a = \) .................................. [3]
12 Solve the simultaneous equations.

\[ \begin{align*}
  x - 5y &= 0 \\
  15x + 10y &= 17
\end{align*} \]

Answer \( x = \) \( y = \) \[3\]

13 The points \( P, Q \) and \( R \) lie on a circle, centre \( O \).
\( TP \) and \( TQ \) are tangents to the circle.
Angle \( TPQ = 54^\circ \).

Calculate the value of

(a) \( x \),

\[ \text{Answer}(a) \ x = \] \[1\]

(b) \( y \),

\[ \text{Answer}(b) \ y = \] \[1\]

(c) \( z \).

\[ \text{Answer}(c) \ z = \] \[2\]
14 60 students recorded their favourite drink. The results are shown in the pie chart.

(a) Calculate the angle for the sector labelled Lemonade.

\[ \text{Answer(a)} \] \[ \text{[1]} \]

(b) Calculate the number of students who chose Banana shake.

\[ \text{Answer(b)} \] \[ \text{[1]} \]

(c) The pie chart has a radius of 3 cm. Calculate the arc length of the sector representing Cola.

\[ \text{Answer(c)} \] \[ \text{cm [2]} \]
15 Write the following as a single fraction in its simplest form.

\[
\frac{x + 1}{x + 5} - \frac{x}{x + 1}
\]

\[\text{Answer} \quad \text{.........................................}[4]\]

16

\[\text{O is the origin and } OABC \text{ is a parallelogram.}
\]
\[CP = PB \text{ and } AQ = QB.\]
\[\overrightarrow{OA} = \mathbf{a} \text{ and } \overrightarrow{OC} = \mathbf{c}.\]

Find in terms of \(a\) and \(c\), in their simplest form,

(a) \(\overrightarrow{PQ}\),

\[\text{Answer(a) } \overrightarrow{PQ} = \text{.........................}[2]\]

(b) the position vector of \(M\), where \(M\) is the midpoint of \(PQ\).

\[\text{Answer(b) } \text{.................................}[2]\]
17. Simplify

(a) \(32x^8 ÷ 8x^{32}\),

\[\text{Answer(a)} \quad \text{..................................................}[2]\]

(b) \(\left( \frac{x^3}{64} \right)^\frac{2}{3}\).

\[\text{Answer(b)} \quad \text{..................................................}[2]\]

18.

The lines \(AB\) and \(CB\) intersect at \(B\).

(a) Find the co-ordinates of the midpoint of \(AB\).

\[\text{Answer(a)} \quad (\ldots\ldots\ldots, \ldots\ldots\ldots) [1]\]

(b) Find the equation of the line \(CB\).

\[\text{Answer(b)} \quad \text{..................................................}[3]\]
19 \( f(x) = x^2 \quad g(x) = 2^x \quad h(x) = 2x - 3 \)

(a) Find \( g(3) \).

Answer(a) .................................. [1]

(b) Find \( hh(x) \) in its simplest form.

Answer(b) .................................. [2]

(c) Find \( fg(x + 1) \) in its simplest form.

Answer(c) .................................. [2]
(a) On the diagram above, using a straight edge and compasses only, construct

(i) the bisector of angle $ABC$, [2]

(ii) the locus of points which are equidistant from $A$ and from $B$. [2]

(b) Shade the region inside the triangle which is nearer to $A$ than to $B$ and nearer to $AB$ than to $BC$. [1]
21 (a) 

\[ A = \begin{pmatrix} 2 & 3 \\ \end{pmatrix} \quad B = \begin{pmatrix} 6 \\ -4 \end{pmatrix} \]

(i) Work out \( AB \).

Answer(a)(i) [2]

(ii) Work out \( BA \).

Answer(a)(ii) [2]

(b) \[ C = \begin{pmatrix} 3 & 1 \\ 1 & 1 \end{pmatrix} \]

Find \( C^{-1} \), the inverse of \( C \).

Answer(b) [2]
1. Factorise completely.

\[2xy - 4yz\]

Answer ......................................... [2]

2. Make \(x\) the subject of the formula.

\[y = \frac{x}{3} + 5\]

Answer \(x = \) .......................................... [2]

3. (a)

Shade the region \(A \cap B'\). .................................. [1]

(b)

This Venn diagram shows the number of elements in each region.

Write down the value of \(n (A \cup B')\).

Answer(b) \(n (A \cup B') = \) .......................................... [1]
4 Helen measures a rectangular sheet of paper as 197 mm by 210 mm, each correct to the nearest millimetre.
Calculate the upper bound for the perimeter of the sheet of paper.

Answer .......................... mm [2]

5

The sketch shows the graph of  \( y = ax^n \) where \( a \) and \( n \) are integers.
Write down a possible value for \( a \) and a possible value for \( n \).

Answer \( a = \) .............................

\( n = \) ............................. [2]

6 (a) Write 16 460 000 in standard form.

Answer(a) ............................. [1]

(b) Calculate  \( 7.85 \div (2.366 \times 10^2) \), giving your answer in standard form.

Answer(b) ............................. [2]
7 (a) Find the value of $x$ when \[
\frac{18}{24} = \frac{27}{x}.
\]

Answer (a) $x = \ldots$ [1]

(b) Show that \[
\frac{2}{3} \div 1\frac{1}{6} = \frac{4}{7}.
\]

Write down all the steps in your working.

Answer (b)

[2]

8 Solve the simultaneous equations.

\[
x + 2y = 3
\]
\[
2x - 3y = 13
\]

Answer $x = \ldots$ [3]

$y = \ldots$ [3]

9 Eva invests $120 at a rate of 3% per year compound interest.

Calculate the total amount Eva has after 2 years.

Give your answer correct to 2 decimal places.

Answer $\ldots$ [3]
10 The cost of a cup of tea is $t$ cents.

The cost of a cup of coffee is $(t + 5)$ cents.

The total cost of 7 cups of tea and 11 cups of coffee is 2215 cents.

Find the cost of one cup of tea.

Answer ................................ cents [3]

11 The volume of a solid varies directly as the cube of its length.

When the length is 3 cm, the volume is $108 \text{ cm}^3$.

Find the volume when the length is 5 cm.

Answer ................................. cm$^3$ [3]
12 Federico changed 400 euros (€) into New Zealand dollars (NZ$) at a rate of $1 = NZ$ 2.1. He spent $x$ New Zealand dollars and changed the rest back into euros at a rate of $1 = NZ$ $d$.

Find an expression, in terms of $x$ and $d$, for the number of euros Federico received.

**Answer**: 

13 The diagram shows the lines $y = 1$, $y = x + 4$ and $y = 4 - x$.

On the diagram, **label the region R** where $y \geq 1$, $y \geq x + 4$ and $y \leq 4 - x$.
The diagram shows the straight line which passes through the points (0, 1) and (3, 13).

Find the equation of the straight line.

Answer ........................................... [3]

15 A cylinder has a height of 12 cm and a volume of 920 cm³.

Calculate the radius of the base of the cylinder.

Answer ........................................... cm [3]
16 Write $\frac{2}{x-2} + \frac{3}{x+2}$ as a single fraction. Give your answer in its simplest form.

Answer .................................. [3]

17

The diagrams show two mathematically similar containers. The larger container has a base with diameter 9 cm and a height 20 cm. The smaller container has a base with diameter $d$ cm and a height 10 cm.

(a) Find the value of $d$.

Answer(a) $d =$ ............................... [1]

(b) The larger container has a capacity of 1600 ml.

Calculate the capacity of the smaller container.

Answer(b) ............................... ml [2]
18 Simplify the following.

(a) \((3x^3)^3\)

Answer(a) ........................................... [2]

(b) \((125x^6)^{\frac{2}{3}}\)

Answer(b) ........................................... [2]

19 The scale of a map is 1 : 250 000.

(a) The actual distance between two cities is 80 km.

Calculate this distance on the map. Give your answer in centimetres.

Answer(a) ........................................... cm [2]

(b) On the map a large forest has an area of 6 cm².

Calculate the actual area of the forest. Give your answer in square kilometres.

Answer(b) ........................................... km² [2]
The diagram shows a circle, centre $O$.
$VT$ is a diameter and $ATB$ is a tangent to the circle at $T$.
$U$, $V$, $W$ and $X$ lie on the circle and angle $VOU = 70^\circ$.

Calculate the value of

(a) $e$,

$$Answer(a) \; e = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [1]$$

(b) $f$,

$$Answer(b) \; f = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [1]$$

(c) $g$,

$$Answer(c) \; g = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [1]$$

(d) $h$,

$$Answer(d) \; h = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [1]$$
The diagram shows a pyramid with a square base $ABCD$ of side 6 cm.

The height of the pyramid, $PM$, is 4 cm, where $M$ is the centre of the base.

Calculate the total surface area of the pyramid.

Answer: $\ldots\ldots\ldots\ldots\ldots\ldots\text{cm}^2$ [5]

Question 22 is printed on the next page.
A train journey takes one hour.
The diagram shows the speed-time graph for this journey.

(a) Calculate the total distance of the journey.

Give your answer in kilometres.

Answer(a) .................................................. km [3]

(b) (i) Convert 3 kilometres/minute into metres/second.

Answer(b)(i) .................................................. m/s [2]

(ii) Calculate the acceleration of the train during the first 4 minutes.

Give your answer in metres/second².

Answer(b)(ii) .................................................. m/s² [2]
READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in. Write in dark blue or black pen. You may use a pencil for any diagrams or graphs. Do not use staples, paper clips, highlighters, glue or correction fluid.

DO NOT WRITE IN ANY BARCODES.

Answer all questions.
If working is needed for any question it must be shown below that question. Electronic calculators should be used.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For \( \pi \) use either your calculator value or 3.142.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 130.
A school has a sponsored swim in summer and a sponsored walk in winter. In 2010, the school raised a total of $1380. The ratio of the money raised in summer: winter = 62:53.

(a) (i) Show clearly that $744 was raised by the swim in summer.

Answer (a)(i) 

(ii) Alesha’s swim raised $54.10. Write this as a percentage of $744.

Answer(a)(ii) %

(iii) Bryan’s swim raised $31.50. He received 75 cents for each length of the pool which he swam.

Calculate the number of lengths Bryan swam.

Answer(a)(iii) 

(b) The route for the sponsored walk in winter is triangular.

(i) Senior students start at A, walk North to B, then walk on a bearing 110° to C. They then return to A. $AB = BC$.

Calculate the bearing of A from C.

Answer(b)(i) 

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Junior students follow a similar path but they only walk 4 km North from A, then 4 km on a bearing 110° before returning to A.

Senior students walk a total of 18.9 km.

Calculate the distance walked by junior students.

\[ AB = BC = 6 \text{ km}. \]

Answer (b)(ii) \[ \text{km} \] [3]

(c) The total amount, $1380, raised in 2010 was 8% less than the total amount raised in 2009.

Calculate the total amount raised in 2009.

Answer (c) $ \[ \text{\$} \] [3]
2 In this question give all your answers as fractions.

The probability that it rains on Monday is \( \frac{3}{5} \).

If it rains on Monday, the probability that it rains on Tuesday is \( \frac{4}{7} \).

If it does not rain on Monday, the probability that it rains on Tuesday is \( \frac{5}{7} \).

(a) Complete the tree diagram.

(b) Find the probability that it rains

(i) on both days,

Answer(b)(i) ............................................. [2]

(ii) on Monday but not on Tuesday,

Answer(b)(ii) ............................................. [2]

(iii) on only one of the two days.

Answer(b)(iii) ............................................. [2]

(c) If it does not rain on Monday and it does not rain on Tuesday, the probability that it does not rain on Wednesday is \( \frac{1}{4} \).

Calculate the probability that it rains on at least one of the three days.

Answer(c) ............................................. [3]
3  (a)  $p$ varies inversely as $(m + 1)$.

When $p = 4$, $m = 8$.

Find the value of $p$ when $m = 11$.

\[ Answer(a) \quad p = \quad \] [3]

(b)  (i) Factorise $x^2 - 25$.

\[ Answer(b)(i) \quad \] [1]

(ii) Simplify $\frac{2x^2 + 11x + 5}{x^2 - 25}$.

\[ Answer(b)(ii) \quad \] [3]

(c) Solve the inequality $5(x - 4) < 3(12 - x)$.

\[ Answer(c) \quad \] [3]
The diagram shows triangle $FGH$, with $FG = 14$ cm, $GH = 12$ cm and $FH = 6$ cm.

(i) Calculate the size of angle $HFG$.

(ii) Calculate the area of triangle $FGH$.
The diagram shows triangle $PQR$, with $RP = 12\text{ cm}$, $RQ = 18\text{ cm}$ and angle $RPQ = 117^\circ$.

Calculate the size of angle $RQP$.

\[
\text{Answer (b) Angle } RQP = \text{...............} \quad [3]
\]
(a) On the grid above, draw the image of

(i) shape A after translation by the vector \( \begin{pmatrix} -3 \\ -2 \end{pmatrix} \), [2]

(ii) shape A after reflection in the line \( x = -1 \). [2]

(b) Describe fully the single transformation which maps

(i) shape A onto shape B,

\( \text{Answer(b)(i)} \) ........................................................................................................... [3]

(ii) shape A onto shape C.

\( \text{Answer(b)(ii)} \) ................................................................................................... [3]

(c) Find the matrix representing the transformation which maps shape A onto shape B.

\( \text{Answer(c)} \) \( \begin{pmatrix} \end{pmatrix} \) [2]

(d) Describe fully the single transformation represented by the matrix \( \begin{pmatrix} -1 & 0 \\ 0 & -1 \end{pmatrix} \).

\( \text{Answer(d)} \) ......................................................................................................... [3]
In the diagram, \( ABCDEF \) is a prism of length 36 cm. The cross-section \( ABC \) is a right-angled triangle. \( AB = 19 \text{ cm} \) and \( AC = 14 \text{ cm} \).

Calculate

(a) the length \( BC \),

\[
\text{Answer(a) } BC = \text{ } \text{ cm} \quad [2]
\]

(b) the total surface area of the prism,

\[
\text{Answer(b) } \text{ cm}^2 \quad [4]
\]

(c) the volume of the prism,

\[
\text{Answer(c) } \text{ cm}^3 \quad [2]
\]

(d) the length \( CE \),

\[
\text{Answer(d) } CE = \text{ } \text{ cm} \quad [2]
\]

(e) the angle between the line \( CE \) and the base \( ABED \).

\[
\text{Answer(e) } \text{ } \text{ } \text{ } \text{ } \text{ } \text{ } [3]
\]
7  (a) Complete the table of values for the equation \( y = \frac{4}{x^2} \), \( x \neq 0 \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>-4</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>-0.6</th>
<th>0.6</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>0.25</td>
<td>0.44</td>
<td></td>
<td></td>
<td>11.11</td>
<td></td>
<td>4.00</td>
<td></td>
<td></td>
<td>0.44</td>
</tr>
</tbody>
</table>

(b) On the grid, draw the graph of \( y = \frac{4}{x^2} \) for \( -4 \leq x \leq -0.6 \) and \( 0.6 \leq x \leq 4 \).
(c) Use your graph to solve the equation \( \frac{4}{x^2} = 6 \).

Answer(c) \( x = \) \underline{\hspace{1.5cm}} \text{ or } x = \underline{\hspace{1.5cm}} \]  

[2]

(d) By drawing a suitable tangent, estimate the gradient of the graph where \( x = 1.5 \).

Answer(d) \underline{\hspace{2.0cm}} \]  

[3]

(e) (i) The equation \( \frac{4}{x^2} - x + 2 = 0 \) can be solved by finding the intersection of the graph of \( y = \frac{4}{x^2} \) and a straight line.

Write down the equation of this straight line.

Answer(e)(i) \underline{\hspace{2.0cm}} \]  

[1]

(ii) On the grid, draw the straight line from your answer to part (e)(i).

[2]

(iii) Use your graphs to solve the equation \( \frac{4}{x^2} - x + 2 = 0 \).

Answer(e)(iii) \( x = \) \underline{\hspace{1.5cm}} \]  

[1]
8 The table below shows the marks scored by a group of students in a test.

<table>
<thead>
<tr>
<th>Mark</th>
<th>11</th>
<th>12</th>
<th>13</th>
<th>14</th>
<th>15</th>
<th>16</th>
<th>17</th>
<th>18</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>10</td>
<td>8</td>
<td>16</td>
<td>11</td>
<td>7</td>
<td>8</td>
<td>6</td>
<td>9</td>
</tr>
</tbody>
</table>

(a) Find the mean, median and mode.

\[ \text{Answer(a) mean} = \] .................................................
\[ \text{median} = \] ................................................
\[ \text{mode} = \] ................................................ [6]

(b) The table below shows the time (t minutes) taken by the students to complete the test.

<table>
<thead>
<tr>
<th>Time (t)</th>
<th>0 &lt; t ≤ 10</th>
<th>10 &lt; t ≤ 20</th>
<th>20 &lt; t ≤ 30</th>
<th>30 &lt; t ≤ 40</th>
<th>40 &lt; t ≤ 50</th>
<th>50 &lt; t ≤ 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>2</td>
<td>19</td>
<td>16</td>
<td>14</td>
<td>15</td>
<td>9</td>
</tr>
</tbody>
</table>

(i) Cara rearranges this information into a new table.

Complete her table.

<table>
<thead>
<tr>
<th>Time (t)</th>
<th>0 &lt; t ≤ 20</th>
<th>20 &lt; t ≤ 40</th>
<th>40 &lt; t ≤ 50</th>
<th>50 &lt; t ≤ 60</th>
</tr>
</thead>
</table>
| Frequency |             |             |             |             | 9           | [2]

(ii) Cara wants to draw a histogram to show the information in part (b)(i).

Complete the table below to show the interval widths and the frequency densities.

<table>
<thead>
<tr>
<th>Interval</th>
<th>0 &lt; t ≤ 20</th>
<th>20 &lt; t ≤ 40</th>
<th>40 &lt; t ≤ 50</th>
<th>50 &lt; t ≤ 60</th>
</tr>
</thead>
<tbody>
<tr>
<td>width</td>
<td></td>
<td>10</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Frequency density |             | 0.9         |             |             | [3]
(c) Some of the students were asked how much time they spent revising for the test.

10 students revised for 2.5 hours, 12 students revised for 3 hours and \( n \) students revised for 4 hours.

The mean time that these students spent revising was 3.1 hours.

Find \( n \).

Show all your working.

\[
Answer(c) \ n = \ldots \ldots \ldots \ldots \ldots \ldots \ldots [4]
\]
Peter wants to plant $x$ plum trees and $y$ apple trees.

He wants at least 3 plum trees and at least 2 apple trees.

(a) Write down one inequality in $x$ and one inequality in $y$ to represent these conditions.

Answer(a) ........................................ , ........................................ [2]

(b) There is space on his land for no more than 9 trees.

Write down an inequality in $x$ and $y$ to represent this condition.

Answer(b) .................................................. [1]

(c) Plum trees cost $6 and apple trees cost $14.

Peter wants to spend no more than $84.

Write down an inequality in $x$ and $y$, and show that it simplifies to $3x + 7y \leq 42$.

Answer(c)
(d) On the grid, draw four lines to show the four inequalities and shade the **unwanted** regions.

![Graph with lines drawn to represent inequalities and shaded regions.]

(e) Calculate the smallest cost when Peter buys a total of 9 trees.

\[ \text{Answer(e)} \; \$ \; \text{________________________} \; [2] \]

Question 10 is printed on the next page.
16

The first and the \( n \)th terms of sequences \( A \), \( B \) and \( C \) are shown in the table below.

(a) Complete the table for each sequence.

<table>
<thead>
<tr>
<th></th>
<th>1st term</th>
<th>2nd term</th>
<th>3rd term</th>
<th>4th term</th>
<th>5th term</th>
<th>( n )th term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence ( A )</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( n^3 )</td>
</tr>
<tr>
<td>Sequence ( B )</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>( 4n )</td>
</tr>
<tr>
<td>Sequence ( C )</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>((n+1)^2)</td>
</tr>
</tbody>
</table>

(b) Find

(i) the 8th term of sequence \( A \),

Answer(b)(i) ........................................... [1]

(ii) the 12th term of sequence \( C \).

Answer(b)(ii) ........................................... [1]

(c) (i) Which term in sequence \( A \) is equal to 15625?

Answer(c)(i) ........................................... [1]

(ii) Which term in sequence \( C \) is equal to 10000?

Answer(c)(ii) ........................................... [1]

(d) The first four terms of sequences \( D \) and \( E \) are shown in the table below.

Use the results from part (a) to find the 5th and the \( n \)th terms of the sequences \( D \) and \( E \).

<table>
<thead>
<tr>
<th></th>
<th>1st term</th>
<th>2nd term</th>
<th>3rd term</th>
<th>4th term</th>
<th>5th term</th>
<th>( n )th term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sequence ( D )</td>
<td>5</td>
<td>16</td>
<td>39</td>
<td>80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sequence ( E )</td>
<td>0</td>
<td>1</td>
<td>4</td>
<td>9</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[5]

For Examiner's Use
1  (a) Work out the following.

(i) \( \frac{1}{0.2^2} \)

Answer(a)(i) ........................................... [1]

(ii) \( \sqrt{5.1^2 + 4 \times 7.3^2} \)

Answer(a)(ii) ........................................... [1]

(iii) \( 25^\frac{1}{2} \times 1000 \times \frac{2}{3} \)

Answer(a)(iii) ........................................... [2]

(b) Mia invests $7500 at 3.5% per year simple interest.
Calculate the total amount she has after 5 years.

Answer(b) $ ........................................... [3]

(c) Written as the product of prime factors \( 48 = 2^4 \times 3 \).

(i) Write 60 as the product of prime factors.

Answer(c)(i) ........................................... [2]

(ii) Work out the highest common factor (HCF) of 48 and 60.

Answer(c)(ii) ........................................... [2]

(iii) Work out the lowest common multiple (LCM) of 48 and 60.

Answer(c)(iii) ........................................... [2]
The diagram shows a box $ABCDEFGH$ in the shape of a cuboid measuring 2 m by 1.5 m by 1.7 m.

(a) Calculate the length of the diagonal $EC$.

$$\text{Answer (a)} \quad EC = \quad \text{m} \quad [4]$$

(b) Calculate the angle between $EC$ and the base $EFGH$.

$$\text{Answer (b)} \quad \text{[3]}$$

(c) (i) A rod has length 2.9 m, correct to 1 decimal place.
What is the upper bound for the length of the rod?

$$\text{Answer (c)(i)} \quad \text{m} \quad [1]$$

(ii) Will the rod fit completely in the box?
Give a reason for your answer.

$$\text{Answer (c)(ii)} \quad \text{[1]}$$
The scale drawing shows the positions of two towns $A$ and $C$ on a map. On the map, 1 centimetre represents 20 kilometres.

(i) Find the distance in kilometres from town $A$ to town $C$.

$Answer(a)(i)$ ........................................... km [2]

(ii) Measure and write down the bearing of town $C$ from town $A$.

$Answer(a)(ii)$ ........................................... [1]

(iii) Town $B$ is 140 km from town $C$ on a bearing of $150^\circ$.

Mark accurately the position of town $B$ on the scale drawing. [2]

(iv) Find the bearing of town $C$ from town $B$.

$Answer(a)(iv)$ ........................................... [1]

(v) A lake on the map has an area of 0.15 cm$^2$.

Work out the actual area of the lake.

$Answer(a)(v)$ ..........................................., km$^2$ [2]
(b) A plane leaves town C at 11.57 and flies 1500 km to another town, landing at 14.12.

Calculate the average speed of the plane.

\[ \text{Answer (b) } \frac{1500 \text{ km}}{2.55 \text{ hr}} \] km/h [3]

(c) The diagram shows the distances between three towns P, Q and R.

Calculate angle \( \angle PQR \).

\[ \text{Answer (c) } \angle PQR = \] \[\] [4]
4 (a) Complete the table of values for the function $y = x^2 - \frac{3}{x}$, $x \neq 0$.

<table>
<thead>
<tr>
<th>$x$</th>
<th>$-3$</th>
<th>$-2$</th>
<th>$-1$</th>
<th>$-0.5$</th>
<th>$0.25$</th>
<th>$0.5$</th>
<th>$1$</th>
<th>$2$</th>
<th>$3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$</td>
<td>10</td>
<td>5.5</td>
<td>6.3</td>
<td>12.1</td>
<td>-11.9</td>
<td>2.5</td>
<td>8</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Draw the graph of $y = x^2 - \frac{3}{x}$ for $-3 \leq x \leq -0.25$ and $0.25 \leq x \leq 3$. 

![Graph of the function $y = x^2 - \frac{3}{x}$](image)
(c) Use your graph to solve \( x^2 - \frac{3}{x} = 7 \).

\[
Answer(c) \quad x = \quad \text{or} \quad x = \quad \text{or} \quad x =
\]

[3]

(d) Draw the tangent to the curve where \( x = -2 \).
Use the tangent to calculate an estimate of the gradient of the curve where \( x = -2 \).

\[
Answer(d) \quad \text{--------------------------}
\]

[3]
5 (a) Solve $9 < 3n + 6 \leq 21$ for integer values of $n$.

$$Answer(a) \……………………………………… \ [3]$$

(b) Factorise completely.

(i) $2x^2 + 10xy$

$$Answer(b)(i) \……………………………………… \ [2]$$

(ii) $3a^2 - 12b^2$

$$Answer(b)(ii) \……………………………………… \ [3]$$

(c)

The area of this triangle is $84 \text{ cm}^2$.

(i) Show that $x^2 + 17x - 168 = 0$.

$$Answer (c)(i) \……………………………………… \ [2]$$

(ii) Factorise $x^2 + 17x - 168$.

$$Answer(c)(ii) \……………………………………… \ [2]$$

(iii) Solve $x^2 + 17x - 168 = 0$.

$$Answer(c)(iii) x = \………………… \text{ or } x = \………………… \ [1]$$
(d) Solve

\[ \frac{15 - x}{2} = 3 - 2x. \]

Answer (d) \( x = \) \[ \text{[3]} \]

(e) Solve \( 2x^2 - 5x - 6 = 0 \).

Show all your working and give your answers correct to 2 decimal places.

Answer (e) \( x = \) \[ \text{[4]} \] or \( x = \) \[ \text{[4]} \]
The table shows the times taken, in minutes, by 150 students to complete their homework on one day.

(a) (i) In which interval is the median time?

Answer(a)(i) ........................................... [1]

(ii) Using the mid-interval values 10, 27.5, ……calculate an estimate of the mean time.

Answer(a)(ii) ........................................... min [3]

(b) (i) Complete the table of cumulative frequencies.

<table>
<thead>
<tr>
<th>Time (t mins)</th>
<th>$t \leq 20$</th>
<th>$t \leq 35$</th>
<th>$t \leq 45$</th>
<th>$t \leq 55$</th>
<th>$t \leq 70$</th>
<th>$t \leq 80$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative frequency</td>
<td>6</td>
<td>21</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

[2]

(ii) On the grid, label the horizontal axis from 0 to 80, using the scale 1 cm represents 5 minutes and the vertical axis from 0 to 150, using the scale 1 cm represents 10 students.

Draw a cumulative frequency diagram to show this information. [5]
(c) Use your graph to estimate

(i) the median time,  \( \text{Answer}(c) (i) \) \[ \text{min} \] [1]

(ii) the inter-quartile range,  \( \text{Answer}(c) (ii) \) \[ \text{min} \] [2]

(iii) the number of students whose time was in the range 50 < \( t \) \( \leq 60 \),  \( \text{Answer}(c) (iii) \) \[ \text{[1]} \]

(iv) the probability, as a fraction, that a student, chosen at random, took longer than 50 minutes,  \( \text{Answer}(c) (iv) \) \[ \text{[2]} \]

(v) the probability, as a fraction, that two students, chosen at random, both took longer than 50 minutes.  \( \text{Answer}(c) (v) \) \[ \text{[2]} \]
A solid pyramid has a **regular hexagon** of side 2.5 cm as its base. Each sloping face is an isosceles triangle with base 2.5 cm and height 9.5 cm.

Calculate the **total** surface area of the pyramid.

**Answer (a)** ........................................... cm$^2$ [4]

(b)

A sector $OAB$ has an angle of $55^\circ$ and a radius of 15 cm.

Calculate the area of the sector and show that it rounds to 108 cm$^2$, correct to 3 significant figures.

**Answer (b)**
(c)

The sector radii \( OA \) and \( OB \) in part (b) are joined to form a cone.

(i) Calculate the base radius of the cone.

\[ \text{Curved surface area, } A = \pi rl \]

Answer (c)(i) \( \text{cm} \) [2]

(ii) Calculate the perpendicular height of the cone.

Answer (c)(ii) \( \text{cm} \) [3]

(d)

A solid cone has the same dimensions as the cone in part (c).

A small cone with slant height 7.5 cm is removed by cutting parallel to the base.

Calculate the volume of the remaining solid.

\[ \text{Volume, } V = \frac{1}{3} \pi r^2 h \]

Answer (d) \( \text{cm}^3 \) [3]
8 (a) Draw the enlargement of triangle $P$ with centre $A$ and scale factor 2. [2]

(b) (i) Describe fully the single transformation which maps shape $Q$ onto shape $R$. 

\[ \text{Answer(b)(i)} \]

(ii) Find the matrix which represents this transformation.

\[ \text{Answer(b)(ii)} \]

(c) Describe fully the single transformation which maps shape $S$ onto shape $T$. 

\[ \text{Answer(c)} \]
9 (a) (i) Work out the first 3 terms of the sequence whose $n$th term is $n(n + 2)$.

\[ \text{Answer}(a)(i) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [2] \]

(ii) Which term in this sequence is equal to 168?

\[ \text{Answer}(a)(ii) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [3] \]

(b) Find a formula for the $n$th term of the following sequences.

(i) 5 8 11 14 17 …

\[ \text{Answer}(b)(i) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [2] \]

(ii) 1 2 4 8 16 …

\[ \text{Answer}(b)(ii) \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [2] \]

(c)

A sequence of diagrams is formed by drawing equilateral triangles each of side one centimetre. Diagram 1 has 3 one centimetre lines. Diagram 2 has 9 one centimetre lines.

The formula for the **total** number of one centimetre lines needed to draw **all of the first $n$ diagrams** is \[ an^3 + bn^2 + n. \]

Find the values of $a$ and $b$.

\[ \text{Answer}(c) a = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [6] \]

\[ b = \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots \ldots [6] \]
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DO NOT WRITE IN ANY BARCODES.

Answer all questions.
If working is needed for any question it must be shown below that question.
Electronic calculators should be used.
If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.
For \( \pi \) use either your calculator value or 3.142.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.
The total of the marks for this paper is 130.

This document consists of 19 printed pages and 1 blank page.
Lucy works in a clothes shop.

(a) In one week she earned $277.20.
   (i) She spent \( \frac{1}{8} \) of this on food.
       Calculate how much she spent on food.

   \[ \text{Answer (a)(i)} $ \] [1]

   (ii) She paid 15% of the $277.20 in taxes.
       Calculate how much she paid in taxes.

   \[ \text{Answer (a)(ii)} $ \] [2]

   (iii) The $277.20 was 5% more than Lucy earned in the previous week.
       Calculate how much Lucy earned in the previous week.

   \[ \text{Answer (a)(iii)} $ \] [3]

(b) The shop sells clothes for men, women and children.

   (i) In one day Lucy sold clothes with a total value of $2200 in the ratio
       Calculate the value of the women’s clothes she sold.

   \[ \text{Answer (b)(i)} $ \] [2]

   (ii) The $2200 was \( \frac{44}{73} \) of the total value of the clothes sold in the shop on this day.
       Calculate the total value of the clothes sold in the shop on this day.

   \[ \text{Answer (b)(ii)} $ \] [2]
(a) (i) Draw the reflection of shape $X$ in the $x$-axis. Label the image $Y$. [2]

(ii) Draw the rotation of shape $Y$, $90^\circ$ clockwise about $(0, 0)$. Label the image $Z$. [2]

(iii) Describe fully the single transformation that maps shape $Z$ onto shape $X$.

Answer(a)(iii) // unfinished

(b) (i) Draw the enlargement of shape $X$, centre $(0, 0)$, scale factor $\frac{1}{2}$. [2]

(ii) Find the matrix which represents an enlargement, centre $(0, 0)$, scale factor $\frac{1}{2}$.

Answer(b)(ii) \[
\begin{pmatrix}
0 & \frac{1}{2} \\
0 & \frac{1}{2}
\end{pmatrix}
\] [2]

(c) (i) Draw the shear of shape $X$ with the $x$-axis invariant and shear factor $-1$. [2]

(ii) Find the matrix which represents a shear with the $x$-axis invariant and shear factor $-1$.

Answer(c)(ii) \[
\begin{pmatrix}
1 & 0 \\
0 & -1
\end{pmatrix}
\] [2]
The diagram shows a square of side \((x + 5)\) cm and a rectangle which measures \(2x\) cm by \(x\) cm.

The area of the square is 1 \(\text{cm}^2\) more than the area of the rectangle.

(a) Show that \(x^2 - 10x - 24 = 0\).

\textit{Answer(a)}
(b) Find the value of $x$.

Answer (b) $x = \phantom{0000}$ [3]

(c) Calculate the acute angle between the diagonals of the rectangle.

Answer (c) $\phantom{0000}$ [3]
The circle, centre $O$, passes through the points $A$, $B$ and $C$.

In the triangle $ABC$, $AB = 8$ cm, $BC = 9$ cm and $CA = 6$ cm.

(a) Calculate angle $BAC$ and show that it rounds to $78.6^\circ$, correct to 1 decimal place.

$Answer(a)$

(b) $M$ is the midpoint of $BC$.

(i) Find angle $BOM$.

$Answer(b)(i)$ Angle $BOM =$ .................................. [1]
(ii) Calculate the radius of the circle and show that it rounds to 4.59 cm, correct to 3 significant figures.

Answer(b)(ii)

(c) Calculate the area of the triangle $ABC$ as a percentage of the area of the circle.

Answer(c) % [4]
5 (a) Complete the table of values for the function \( f(x) \), where \( f(x) = x^2 + \frac{1}{x^2}, \ x \neq 0 \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>-3</th>
<th>-2.5</th>
<th>-2</th>
<th>-1.5</th>
<th>-1</th>
<th>-0.5</th>
<th>0.5</th>
<th>1</th>
<th>1.5</th>
<th>2</th>
<th>2.5</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( f(x) )</td>
<td>6.41</td>
<td>2.69</td>
<td>4.25</td>
<td>4.25</td>
<td>2.69</td>
<td>6.41</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) On the grid, draw the graph of \( y = f(x) \) for \(-3 \leq x \leq -0.5\) and \(0.5 \leq x \leq 3\).
(c)  (i) Write down the equation of the line of symmetry of the graph.

*Answer(c)(i)  ........................................ [1]*

(ii) Draw the tangent to the graph of $y = f(x)$ where $x = -1.5$.
Use the tangent to estimate the gradient of the graph of $y = f(x)$ where $x = -1.5$.

*Answer(c)(ii)  ........................................ [3]*

(iii) Use your graph to solve the equation $x^2 + \frac{1}{x^2} = 3$.

*Answer(c)(iii) $x = ...........$ or $x = ...........$ or $x = ...........$ or $x = ...........$ [2]*

(iv) Draw a suitable line on the grid and use your graphs to solve the equation $x^2 + \frac{1}{x^2} = 2x$.

*Answer(c)(iv) $x = ...........$ or $x = ...........$ [3]*
The masses of 200 parcels are recorded.

The results are shown in the cumulative frequency diagram above.

(a) Find

(i) the median,

Answer(a)(i) .................................. kg [1]

(ii) the lower quartile,

Answer(a)(ii) .................................. kg [1]

(iii) the inter-quartile range,

Answer(a)(iii) .................................. kg [1]

(iv) the number of parcels with a mass greater than 3.5 kg.

Answer(a)(iv) .................................. [2]
(b) (i) Use the information from the cumulative frequency diagram to complete the grouped frequency table.

<table>
<thead>
<tr>
<th>Mass (m) kg</th>
<th>0 &lt; m ≤ 4</th>
<th>4 &lt; m ≤ 6</th>
<th>6 &lt; m ≤ 7</th>
<th>7 &lt; m ≤ 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>36</td>
<td></td>
<td></td>
<td>50</td>
</tr>
</tbody>
</table>

(ii) Use the grouped frequency table to calculate an estimate of the mean.

\[ \text{Answer (b)(ii)} \quad \text{kg} \quad [4] \]

(iii) Complete the frequency density table and use it to complete the histogram.

<table>
<thead>
<tr>
<th>Mass (m) kg</th>
<th>0 &lt; m ≤ 4</th>
<th>4 &lt; m ≤ 6</th>
<th>6 &lt; m ≤ 7</th>
<th>7 &lt; m ≤ 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency density</td>
<td>9</td>
<td></td>
<td>16.7</td>
<td></td>
</tr>
</tbody>
</table>

[4]
Katrina puts some plants in her garden.

The probability that a plant will produce a flower is \( \frac{7}{10} \).

If there is a flower, it can only be red, yellow or orange.

When there is a flower, the probability it is red is \( \frac{2}{3} \) and the probability it is yellow is \( \frac{1}{4} \).

(a) Draw a tree diagram to show all this information.

Label the diagram and write the probabilities on each branch.

\[ \text{Answer(a)} \]

(b) A plant is chosen at random.

Find the probability that it will not produce a yellow flower.

\[ \text{Answer(b)} \]

(c) If Katrina puts 120 plants in her garden, how many orange flowers would she expect?

\[ \text{Answer(c)} \]
(a) Draw accurately the locus of points, inside the quadrilateral $ABCD$, which are 6 cm from the point $D$. [1]

(b) Using a straight edge and compasses only, construct

(i) the perpendicular bisector of $AB$, [2]

(ii) the locus of points, inside the quadrilateral, which are equidistant from $AB$ and from $BC$. [2]

(c) The point $Q$ is equidistant from $A$ and from $B$ and equidistant from $AB$ and from $BC$.

(i) Label the point $Q$ on the diagram. [1]

(ii) Measure the distance of $Q$ from the line $AB$.

Answer(c)(ii) ........................................ cm [1]

(d) On the diagram, shade the region inside the quadrilateral which is

- less than 6 cm from $D$ and
- nearer to $A$ than to $B$ and
- nearer to $AB$ than to $BC$. [1]
9 \[ f(x) = 3x + 1 \quad g(x) = (x + 2)^2 \]

(a) Find the values of

(i) \[ gf(2) \].

(ii) \[ ff(0.5) \].

(b) Find \( f^{-1}(x) \), the inverse of \( f(x) \).

(c) Find \( fg(x) \).

Give your answer in its simplest form.
(d) Solve the equation \( x^2 + f(x) = 0. \)

Show all your working and give your answers correct to 2 decimal places.

Answer (d) \( x = \ldots \quad \text{or} \quad x = \ldots \) \[4\]
ABCD is a parallelogram. 
L is the midpoint of DC, M is the midpoint of BC and N is the midpoint of LM. 
\( \overrightarrow{AB} = p \) and \( \overrightarrow{AD} = q \).

(i) Find the following in terms of \( p \) and \( q \), in their simplest form.

(a) \( \overrightarrow{AC} \)

Answer(a)(i)(a) \( \overrightarrow{AC} = \) ........................................... [1]

(b) \( \overrightarrow{LM} \)

Answer(a)(i)(b) \( \overrightarrow{LM} = \) ........................................... [2]

(c) \( \overrightarrow{AN} \)

Answer(a)(i)(c) \( \overrightarrow{AN} = \) ........................................... [2]

(ii) Explain why your answer for \( \overrightarrow{AN} \) shows that the point \( N \) lies on the line \( AC \).

Answer(a)(ii) ................................................................. [1]
(b) \[ \begin{align*}
EFG \text{ is a triangle.} \\
HJ \text{ is parallel to } FG. \\
\text{Angle } FEG &= 75^\circ. \\
\text{Angle } EFG &= 2x^\circ \text{ and angle } FGE = (x + 15)^\circ.
\end{align*} \]

(i) Find the value of \(x\).

\[ \text{Answer (b)(i) } x = \] [2]

(ii) Find angle \(HJG\).

\[ \text{Answer (b)(ii) Angle } HJG = \] [1]
11 (a) (i) The first three positive integers 1, 2 and 3 have a sum of 6.

Write down the sum of the first 4 positive integers.

Answer (a)(i) .................................................. [1]

(ii) The formula for the sum of the first \( n \) integers is \( \frac{n(n + 1)}{2} \).

Show the formula is correct when \( n = 3 \).

Answer (a)(ii) .................................................. [1]

(iii) Find the sum of the first 120 positive integers.

Answer (a)(iii) .................................................. [1]

(iv) Find the sum of the integers

\[121 + 122 + 123 + 124 + \ldots + 199 + 200.\]

Answer (a)(iv) .................................................. [2]

(v) Find the sum of the even numbers

\[2 + 4 + 6 + \ldots + 800.\]

Answer (a)(v) .................................................. [2]
(b) (i) Complete the following statements about the sums of cubes and the sums of integers.

\[
\begin{align*}
1^3 &= 1 & 1 &= 1 \\
1^3 + 2^3 &= 9 & 1+2 &= 3 \\
1^3 + 2^3 + 3^3 &= & 1+2+3 &= \\
1^3 + 2^3 + 3^3 + 4^3 &= & 1+2+3+4 &= \text{[2]}
\end{align*}
\]

(ii) The sum of the first 14 integers is 105.

Find the sum of the first 14 cubes.

Answer(b)(ii) \……………………………………… [1]

(iii) Use the formula in part(a)(ii) to write down a formula for the sum of the first \( n \) cubes.

Answer(b)(iii) \……………………………………… [1]

(iv) Find the sum of the first 60 cubes.

Answer(b)(iv) \……………………………………… [1]

(v) Find \( n \) when the sum of the first \( n \) cubes is 278 784.

Answer(b)(v) \( n = \) \……………………………………… [2]
QUESTION BANK
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Compiled & Edited By

Dr. Eltayeb Abdul Rhman

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