1 Vreni took part in a charity walk. She walked a distance of 20 kilometres.

(a) She raised money at a rate of $12.50 for each kilometre.

(i) How much money did she raise by walking the 20 kilometres? [1]

(ii) The money she raised in part (a)(i) was \( \frac{5}{52} \) of the total money raised. Work out the total money raised. [2]

(iii) In the previous year the total money raised was $2450. Calculate the percentage increase on the previous year’s total. [2]

(b) Part of the 20 kilometres was on a road and the rest was on a footpath. The ratio road distance : footpath distance was 3:2.

(i) Work out the road distance. [2]

(ii) Vreni walked along the road at 3 km/h and along the footpath at 2.5 km/h. How long, in hours and minutes, did Vreni take to walk the 20 kilometres? [2]

(iii) Work out Vreni’s average speed. [1]

(iv) Vreni started at 08.55. At what time did she finish? [1]

(c) On a map, the distance of 20 kilometres was represented by a length of 80 centimetres. The scale of the map was 1 : n. Calculate the value of n. [2]

2 (a) (i) Factorise \( x^2 - x - 20 \). [2]

(ii) Solve the equation \( x^2 - x - 20 = 0 \). [1]

(b) Solve the equation \( 3x^2 - 2x - 2 = 0 \). Show all your working and give your answers correct to 2 decimal places. [4]

(c) \( y = m^2 - 4n^2 \).

(i) Factorise \( m^2 - 4n^2 \). [1]

(ii) Find the value of \( y \) when \( m = 4.4 \) and \( n = 2.8 \). [1]

(iii) \( m = 2x + 3 \) and \( n = x - 1 \). Find \( y \) in terms of \( x \), in its simplest form. [2]

(iv) Make \( n \) the subject of the formula \( y = m^2 - 4n^2 \). [3]
(d) (i) \( m^4 - 16n^4 \) can be written as \((m^2 - kn^2)(m^2 + kn^2)\).
Write down the value of \(k\). \[1\]

(ii) Factorise completely \( m^4n - 16n^5 \). \[2\]

3 (a)

Nadia must choose a ball from Bag A or from Bag B.
The probability that she chooses Bag A is \( \frac{2}{3} \).
Bag A contains 5 white and 3 black balls.
Bag B contains 6 white and 2 black balls.

The tree diagram below shows some of this information.

(i) Find the values of \(p\), \(q\), \(r\) and \(s\). \[3\]

(ii) Find the probability that Nadia chooses Bag A and then a white ball. \[2\]

(iii) Find the probability that Nadia chooses a white ball. \[2\]

(b) Another bag contains 7 green balls and 3 yellow balls.
Sani takes three balls out of the bag, without replacement.

(i) Find the probability that all three balls he chooses are yellow. \[2\]

(ii) Find the probability that at least one of the three balls he chooses is green. \[1\]
200 people record the number of hours they work in a week. The cumulative frequency graph shows this information.
(a) Use the graph to find

(i) the median, [1]

(ii) the upper quartile, [1]

(iii) the inter-quartile range, [1]

(iv) the number of people who work more than 60 hours in a week. [2]

(b) Omar uses the graph to make the following frequency table.

<table>
<thead>
<tr>
<th>Hours worked (h)</th>
<th>0&lt;h≤10</th>
<th>10&lt;h≤20</th>
<th>20&lt;h≤30</th>
<th>30&lt;h≤40</th>
<th>40&lt;h≤50</th>
<th>50&lt;h≤60</th>
<th>60&lt;h≤70</th>
<th>70&lt;h≤80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>12</td>
<td>34</td>
<td>36</td>
<td>30</td>
<td>38</td>
<td>30</td>
<td>p</td>
<td>q</td>
</tr>
</tbody>
</table>

(i) Use the graph to find the values of p and q. [2]

(ii) Calculate an estimate of the mean number of hours worked in a week. [4]

(c) Shalini uses the graph to make a different frequency table.

<table>
<thead>
<tr>
<th>Hours worked (h)</th>
<th>0&lt;h≤30</th>
<th>30&lt;h≤40</th>
<th>40&lt;h≤50</th>
<th>50&lt;h≤80</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>82</td>
<td>30</td>
<td>38</td>
<td>50</td>
</tr>
</tbody>
</table>

When she draws a histogram, the height of the column for the interval 30<h≤40 is 9 cm.

Calculate the height of each of the other three columns. [4]
A circle, centre $O$, touches all the sides of the regular octagon $ABCDEFGH$ shaded in the diagram.

The sides of the octagon are of length 12 cm.

$BA$ and $GH$ are extended to meet at $P$. $HG$ and $EF$ are extended to meet at $Q$.

(a)  
(i) Show that angle $BAH$ is $135^\circ$. \[2\]
(ii) Show that angle $APH$ is $90^\circ$. \[1\]

(b) Calculate

(i) the length of $PH$, \[2\]
(ii) the length of $PQ$, \[2\]
(iii) the area of triangle $APH$, \[2\]
(iv) the area of the octagon. \[3\]

(c) Calculate

(i) the radius of the circle, \[2\]
(ii) the area of the circle as a percentage of the area of the octagon. \[3\]
The pentagon $OABCD$ is shown on the grid above.

(a) Write as column vectors

(i) $\overrightarrow{OD}$, [1]

(ii) $\overrightarrow{BC}$. [1]

(b) Describe fully the single transformation which maps the side $BC$ onto the side $OD$. [2]

(c) The shaded area inside the pentagon is defined by 5 inequalities.

One of these inequalities is $y \leq \frac{1}{2} x + 4$.

Find the other 4 inequalities. [5]
A, B, C and D lie on a circle, centre O.
SCT is the tangent at C and is parallel to OB.
Angle AOB = 130°, and angle BCT = 40°.
Angle OBC = x°, angle OBA = y° and angle ADC = z°.

(i) Write down the geometrical word which completes the following statement.

"ABCD is a __________________ quadrilateral." [1]

(ii) Find the values of x, y and z. [3]

(iii) Write down the value of angle OCT. [1]

(iv) Find the value of the reflex angle AOC. [1]
(b)

$P, Q, R$ and $S$ lie on a circle.

$PQ = 7\text{ cm}$ and $SR = 10\text{ cm}$.

$PR$ and $QS$ intersect at $X$.

The area of triangle $SRX = 20\text{ cm}^2$.

(i) Write down the geometrical word which completes the following statement.

“Triangle $PQX$ is _________ to triangle $SRX$.”

(ii) Calculate the area of triangle $PQX$.

(iii) Calculate the length of the perpendicular height from $X$ to $RS$.
8 Answer the whole of this question on a sheet of graph paper. Use one side for your working and one side for your graphs.

Alaric invests $100 at 4% per year compound interest.

(a) How many dollars will Alaric have after 2 years? [2]

(b) After $x$ years, Alaric will have $y$ dollars. He knows a formula to calculate $y$. The formula is $y = 100 \times 1.04^x$

<table>
<thead>
<tr>
<th>$x$ (Years)</th>
<th>0</th>
<th>10</th>
<th>20</th>
<th>30</th>
<th>40</th>
</tr>
</thead>
<tbody>
<tr>
<td>$y$ (Dollars)</td>
<td>100</td>
<td>$p$</td>
<td>219</td>
<td>$q$</td>
<td>480</td>
</tr>
</tbody>
</table>

Use this formula to calculate the values of $p$ and $q$ in the table. [2]

(c) Using a scale of 2 cm to represent 5 years on the $x$-axis and 2 cm to represent $50$ on the $y$-axis, draw an $x$-axis for $0 \leq x \leq 40$ and a $y$-axis for $0 \leq y \leq 500$.

Plot the five points in the table and draw a smooth curve through them. [5]

(d) Use your graph to estimate
   (i) how many dollars Alaric will have after 25 years, [1]
   (ii) how many years, to the nearest year, it takes for Alaric to have $200$. [1]

(e) Beatrice invests $100 at 7% per year simple interest.
   (i) Show that after 20 years Beatrice has $240. [2]
   (ii) How many dollars will Beatrice have after 40 years? [1]
   (iii) On the same grid, draw a graph to show how the $100$ which Beatrice invests will increase during the 40 years. [2]

(f) Alaric first has more than Beatrice after $n$ years. Use your graphs to find the value of $n$. [1]
OPQR is a parallelogram.
O is the origin.
\( \overrightarrow{OP} = p \) and \( \overrightarrow{OR} = r \).
M is the mid-point of PQ and L is on OR such that \( OL:LR = 2:1 \).
The line PL is extended to the point S.

(a) Find, in terms of \( p \) and \( r \), in their simplest forms,

(i) \( \overrightarrow{OQ} \),

(ii) \( \overrightarrow{PR} \),

(iii) \( \overrightarrow{PL} \),

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

(b) PLS is a straight line and \( PS = \frac{3}{2} PL \).
Find, in terms of \( p \) and/or \( r \), in their simplest forms,

(i) \( \overrightarrow{PS} \),

(ii) \( \overrightarrow{QS} \).

(c) What can you say about the points \( Q \), \( R \) and \( S \)?
A 3 by 3 square can be chosen from the 6 by 6 grid above.

\[
\begin{array}{|c|c|c|}
\hline
x & b & c \\
\hline
d & e & f \\
\hline
g & h & i \\
\hline
\end{array}
\]

(a) One of these squares is

\[
\begin{array}{|c|c|c|}
\hline
8 & 9 & 10 \\
\hline
14 & 15 & 16 \\
\hline
20 & 21 & 22 \\
\hline
\end{array}
\]

In this square, \( x = 8, c = 10, g = 20 \) and \( i = 22 \).

For this square, calculate the value of

(i) \((i - x) - (g - c)\), \[1\]

(ii) \(cg - xi\). \[1\]

(b)

(i) \(c = x + 2\). Write down \(g\) and \(i\) in terms of \(x\). \[2\]

(ii) Use your answers to part(b)(i) to show that \((i - x) - (g - c)\) is constant. \[1\]

(iii) Use your answers to part(b)(i) to show that \(cg - xi\) is constant. \[2\]
(c) The 6 by 6 grid is replaced by a 5 by 5 grid as shown.

\[
\begin{array}{cccc}
1 & 2 & 3 & 4 \\
6 & 7 & 8 & 9 \\
11 & 12 & 13 & 14 \\
16 & 17 & 18 & 19 \\
21 & 22 & 23 & 24 & 25 \\
\end{array}
\]

A 3 by 3 square can be chosen from the 5 by 5 grid.

\[
\begin{array}{ccc}
x & b & c \\
d & e & f \\
g & h & i \\
\end{array}
\]

For any 3 by 3 square chosen from this 5 by 5 grid, calculate the value of

(i) \((i - x) - (g - c)\), \[1\]

(ii) \(cg - xi\). \[1\]

(d) A 3 by 3 square is chosen from an \(n\) by \(n\) grid.

(i) Write down the value of \((i - x) - (g - c)\). \[1\]

(ii) Find \(g\) and \(i\) in terms of \(x\) and \(n\). \[2\]

(iii) Find \(cg - xi\) in its simplest form. \[1\]