IN FIGURES

Student number: ________________________

IN WORDS

____________________________________

MATHEMATICS APPLICATIONS

Section Two: Calculator-assumed

Time allowed for this section
Reading time before commencing work: ten minutes
Working time: one hundred minutes

Materials required/recommended for this section
To be provided by the supervisor
This Question/Answer booklet
Formula sheet (retained from Section One)

To be provided by the candidate
Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters
Special items: drawing instruments, templates, notes on two unfolded sheets of A4 paper, and up to three calculators approved for use in this examination

Important note to candidates
No other items may be taken into the examination room. It is your responsibility to ensure that you do not have any unauthorised material. If you have any unauthorised material with you, hand it to the supervisor before reading any further.

Ref: 17-047

MAA-S2

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Structure of this paper

<table>
<thead>
<tr>
<th>Section</th>
<th>Number of questions available</th>
<th>Number of questions to be answered</th>
<th>Working time (minutes)</th>
<th>Marks available</th>
<th>Percentage of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section One: Calculator-free</td>
<td>7</td>
<td>7</td>
<td>50</td>
<td>53</td>
<td>35</td>
</tr>
<tr>
<td>Section Two: Calculator-assumed</td>
<td>9</td>
<td>9</td>
<td>100</td>
<td>94</td>
<td>65</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>100</strong></td>
</tr>
</tbody>
</table>

Instructions to candidates

1. The rules for the conduct of the Western Australian external examinations are detailed in the Year 12 Information Handbook 2017. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer booklet.

3. You must be careful to confine your answers to the specific question asked and to follow any instructions that are specified to a particular question.

4. Supplementary pages for the use of planning/continuing your answer to a question have been provided at the end of this Question/Answer booklet. If you use these pages to continue an answer, indicate at the original answer where the answer is continued, i.e. give the page number.

5. Show all your working clearly. Your working should be in sufficient detail to allow your answers to be checked readily and for marks to be awarded for reasoning. Incorrect answers given without supporting reasoning cannot be allocated any marks. For any question or part question worth more than two marks, valid working or justification is required to receive full marks. If you repeat any question, ensure that you cancel the answer you do not wish to have marked.

6. It is recommended that you do not use pencil, except in diagrams.

7. The Formula sheet is not to be handed in with your Question/Answer booklet.
Ming, a former high school student and now a successful business owner, wishes to set up a perpetuity of $6000 per year to be paid to a deserving student from her school. The perpetuity is to be paid at the start of the year in one single payment.

(a) A financial institution has agreed to maintain an account for this perpetuity paying a fixed rate of 5.9% p.a. compounded monthly.

Show that an amount of $98,974, to the nearest dollar, is required to maintain this perpetuity. (3 marks)

(b) Ming allows herself five years to accumulate the required $98,974 by making regular quarterly payments into an account paying 5.4% p.a. compounded monthly.

Determine the quarterly payment needed to reach the required amount after five years if Ming starts the account with an initial deposit of $1000. (3 marks)
The World Health Organisation produces tables showing Child Growth Standards. The median lengths (cm) for girls at various times during the first five years of life are shown below.

<table>
<thead>
<tr>
<th>Age (months)</th>
<th>0</th>
<th>3</th>
<th>12</th>
<th>21</th>
<th>27</th>
<th>42</th>
<th>48</th>
<th>60</th>
</tr>
</thead>
<tbody>
<tr>
<td>Median length (cm)</td>
<td>49.1</td>
<td>59.8</td>
<td>74.0</td>
<td>83.7</td>
<td>88.3</td>
<td>99.0</td>
<td>102.7</td>
<td>109.4</td>
</tr>
<tr>
<td>Predicted length (cm)</td>
<td>58.2</td>
<td>61.0</td>
<td>69.5</td>
<td>77.9</td>
<td>A</td>
<td>97.7</td>
<td>B</td>
<td>114.7</td>
</tr>
<tr>
<td>Residual</td>
<td>–9.1</td>
<td>–1.2</td>
<td>4.5</td>
<td>5.8</td>
<td>4.7</td>
<td>1.3</td>
<td>C</td>
<td>D</td>
</tr>
</tbody>
</table>

(a) (i) Determine the equation of the least-squares line for predicting the median length from a girl’s age. (1 mark)

(ii) Use the equation from (a)(i) to determine the predicted median lengths $A$ and $B$ in the above table.

$A = \underline{\phantom{0000}}$  
$B = \underline{\phantom{0000}}$  

(2 marks)

(iii) What increase in median length can be expected for each additional year?  

(1 mark)

(iv) Given that the correlation coefficient is 0.97, describe the association between age and median length in terms of its direction and strength.  

(2 marks)

(v) What percentage of the variation in the median length can be explained by the variation in age?  

(1 mark)
(b)  
(i) Determine the residuals $C$ and $D$ in the table.

\[ C = \quad \]  
\[ D = \quad \] \hspace{1cm} (2 \text{ marks})

(ii) Hence, complete the scattergraph of the residuals against age on the axes below by plotting the last four residual values. \hspace{1cm} (2 \text{ marks})

(iii) Use the residual plot to assess the appropriateness of fitting a linear model to the data. \hspace{1cm} (2 \text{ marks})
Question 10  

In a laboratory experiment, the population of a particular bacteria began with 400 present. The bacteria grew at a rate of 35% each week, where \( P \) is the number of bacteria and \( t \) is the number of weeks from the start of the experiment.

(a) Four possible equations were produced to model this experiment:

\[ P = 400(1.35)^t \]
\[ P = 400(0.35)^t \]
\[ P = 540(1.35)^{t-1} \]
\[ P = 540(1.35)^{t+1}. \]

Circle the correct equation(s).  

(b) Calculate the population of bacteria after three weeks.  

(c) During which week did the population of bacteria first reach 1800?  

(d) After eight weeks the growth rate slowed to 20% each week. How many weeks in total did it take for the population of bacteria to reach 15,812?  

(e) What constant weekly growth rate would produce the same change in population from 400 to 15,812 in the same time as found in part (d)?  

(f) Once the bacteria population reached 15,812 it began to die out at a rate of 250 each day. Approximately how many weeks did it take for the bacteria to die out completely?
The following table, consisting of 11 activities, contains information for a project in a small manufacturing company.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Immediate Predecessors</th>
<th>Time (hours)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>–</td>
<td>4</td>
</tr>
<tr>
<td>B</td>
<td>–</td>
<td>5</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
<td>14</td>
</tr>
<tr>
<td>D</td>
<td>A</td>
<td>7</td>
</tr>
<tr>
<td>E</td>
<td>–</td>
<td>7</td>
</tr>
<tr>
<td>F</td>
<td>–</td>
<td>5</td>
</tr>
<tr>
<td>G</td>
<td>B, C</td>
<td>7</td>
</tr>
<tr>
<td>H</td>
<td>D</td>
<td>6</td>
</tr>
<tr>
<td>J</td>
<td>E, F</td>
<td>9</td>
</tr>
<tr>
<td>K</td>
<td>H, J</td>
<td>10</td>
</tr>
<tr>
<td>L</td>
<td>G, K</td>
<td>6</td>
</tr>
</tbody>
</table>

(a) Complete the project network below. (3 marks)

(b) State the critical path and the minimum completion time for this network. (2 marks)

(c) Determine the float time, earliest starting time, and latest starting time for Activity G. (3 marks)

(d) Due to some unforeseen problems with Activities G and J, one of these activities will require an extra three hours to complete. Which of the activities should be chosen for the completion time to be at a minimum? Justify your answer. (3 marks)
The Bureau of Meteorology recorded data taken from several weather stations. The scatterplot below shows the height, $h$ (m), of each weather station above sea level and the mean minimum temperature, $t$ (°C), recorded at that station for the month of April.

The following table provides information for three more weather stations for the month of April.

| Height of weather station above sea level, $h$ (m) | 250 | 60 | 930 |
| Mean minimum temperature, $t$ (°C)              | 13.1 | 26.2 | 10.6 |

(a) Plot this additional information on the scatterplot above. 

(b) The equation of the least-squares line for these data is $t = -0.015h + 21.476$. Draw this line on the scatterplot above.
(c) The correlation coefficient ($r$) was determined for the collected data. Circle the value of $r$ most likely to be the result from the list below.  

\[
\begin{align*}
  r & = -1.2 \\
  r & = -0.8 \\
  r & = -0.2 \\
  r & = 0.5 \\
  r & = 0.9 
\end{align*}
\]  

(1 mark)

(d) Identify whether the nature of the relationship between the height of a weather station above sea level, $h$, and the mean minimum temperature, $t$ (°C), is linear or non-linear.  

(1 mark)

(e) A spokesperson for the Bureau of Meteorology summarised the information from parts (a)–(d), saying 'It is evident that raising the height of a weather station above sea level causes the mean minimum temperature to drop'. Is this statement correct? Justify your decision.  

(2 marks)
Question 13  (8 marks)

The traffic flow (in hundreds of cars per hour) through a road network (F to H) is shown below.

(a) By listing the different paths and their flow rate, determine the maximum flow through the network. (4 marks)

(b) Verify the maximum flow obtained in part (a) by showing the minimum cut on the given network. (1 mark)

(c) (i) If one road is to be widened to allow for more traffic, which road should be chosen to increase the maximum flow the most? (1 mark)

(ii) How much more traffic should this road allow to flow and what would be the new maximum flow for the network? (2 marks)
Question 14 (13 marks)

Andrew takes out a $14,999 loan to purchase his first car after paying a $1,200 deposit. The car dealer offered the loan at an introductory interest rate of 1.80% p.a. for the first year and then the rate becomes 3.24% p.a. for the remaining time of the loan. Interest is added monthly and Andrew has calculated he can afford to make monthly repayments of $420.

(a) (i) Express the loan repayment process for the first year as a recursive formula. (2 marks)

(ii) How much does Andrew still owe after one year? (1 mark)

(b) How much does Andrew owe after two years? (3 marks)

c) How long does it take Andrew to repay the loan? (2 marks)

d) Determine the amount of the final repayment. (2 marks)

e) Calculate the total cost of the car. (3 marks)
Question 15  

(a) The table below shows some time series data where \( t \) represents time.

<table>
<thead>
<tr>
<th>( t )</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>( x )</td>
<td>14</td>
<td>17</td>
<td>18</td>
<td>24</td>
<td>21</td>
<td>19</td>
<td>16</td>
<td>13</td>
</tr>
</tbody>
</table>

Calculate at \( t = 4 \)

(i) the 3-point moving average.  

(ii) the 6-point centred moving average.

(b) A retailer in a shopping centre sells mobile phones. The data of its quarterly sales, together with some calculations, are shown in the table below.

<table>
<thead>
<tr>
<th>Year</th>
<th>Data number ((n))</th>
<th>Quarter</th>
<th>Mobile phone sales</th>
<th>Quarterly mean</th>
<th>Percentage of quarterly mean</th>
<th>Deseasonalised figure ((D))</th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>1</td>
<td>March</td>
<td>901</td>
<td>905</td>
<td>99.56</td>
<td>915</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>June</td>
<td>802</td>
<td></td>
<td>88.62</td>
<td>914</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>September</td>
<td>(A)</td>
<td></td>
<td>97.68</td>
<td>900</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>December</td>
<td>1033</td>
<td></td>
<td>114.14</td>
<td>894</td>
</tr>
<tr>
<td>2014</td>
<td>5</td>
<td>March</td>
<td>973</td>
<td>984.5</td>
<td>98.83</td>
<td>988</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>June</td>
<td>863</td>
<td></td>
<td>(C)</td>
<td>984</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>September</td>
<td>964</td>
<td></td>
<td>97.92</td>
<td>981</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>December</td>
<td>1138</td>
<td></td>
<td>115.59</td>
<td>985</td>
</tr>
<tr>
<td>2015</td>
<td>9</td>
<td>March</td>
<td>1049</td>
<td>1065.5</td>
<td>98.45</td>
<td>1065</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>June</td>
<td>932</td>
<td></td>
<td>87.47</td>
<td>(E)</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>September</td>
<td>1049</td>
<td></td>
<td>98.45</td>
<td>1068</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>December</td>
<td>1232</td>
<td></td>
<td>115.63</td>
<td>1066</td>
</tr>
<tr>
<td>2016</td>
<td>13</td>
<td>March</td>
<td>1119</td>
<td></td>
<td>97.01</td>
<td>1136</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td>June</td>
<td>1006</td>
<td></td>
<td>87.21</td>
<td>1147</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>September</td>
<td>1142</td>
<td></td>
<td>99.00</td>
<td>1162</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>December</td>
<td>1347</td>
<td></td>
<td>116.78</td>
<td>1166</td>
</tr>
</tbody>
</table>
(i) Determine the value of $A$, $B$ and $C$ in the table in part (b) on the previous page. (3 marks)

(ii) Complete the Seasonal Index table below. (1 mark)

<table>
<thead>
<tr>
<th>Quarter</th>
<th>March</th>
<th>June</th>
<th>September</th>
<th>December</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seasonal Index</td>
<td>0.9846</td>
<td>0.8774</td>
<td>0.9826</td>
<td></td>
</tr>
</tbody>
</table>

(iii) Determine the value of $E$ in the table in part (b) on the previous page. (2 marks)

The equation of the least-squares line for deseasonalised figure against data number is $D = 19.37n + 862.4$.

(iv) The graph below shows the deseasonalised figures. Draw, on the graph, the least-squares line. (2 marks)

(v) Predict the mobile phone sales for December 2017. (2 marks)

(vi) Comment on the reliability of your prediction made in part (v). (2 marks)
Question 16 (8 marks)

In a Northern Territory river, the crocodile population is dropping by 7.5% each year. The current population is 200. A scheme is being trialled under which 20 crocodiles are introduced to the river each year.

The population of crocodiles in the river can be modelled by the first-order linear recurrence relation \( T_{n+1} = 0.925T_n + b \), \( T_1 = 200 \), where \( T_n \) is the number of crocodiles in the river at the beginning of the \( n^{th} \) year.

(a) (i) Interpret the coefficient 0.925 in the context of the question. (1 mark)

(ii) State the value of \( b \). (1 mark)

(b) Graph the number of crocodiles in the river for every five year period (commencing at \( n = 5 \)), up to the 30th year on the axes below. (2 marks)

(c) Using your graph, comment on how the population of crocodiles is changing over time. (2 marks)

(d) To the nearest whole number, what is the long-term effect on the crocodile population? (2 marks)

End of questions
Supplementary page

Question number: _____________
ACKNOWLEDGEMENTS

Question 9  