**MATHEMATICS APPLICATIONS**

**MAWA Semester 2 (Units 3 & 4)**

**Examination 2019**

**Calculator-Assumed**

# Marking Key

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The release date for this exam and marking scheme is

* **the end of week 1 of term 4, 2019**

**Section Two: Calculator-assumed (102 Marks)**

**Question 7 (a) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
|  | |
| Marking key/mathematical behaviours | Marks |
| * labels Jennifer and Peter correctly * identifies painting and tiling correctly * draws the correct links for Peter | 1  1  1 |

**Question 7 (b) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
| Bipartite graph  The information given is in two separate groups or sets. People and tasks. The vertices represent the two groups and the edges represent the links or connections between the two groups. A bipartite graph makes this clear. | |
| Marking key/mathematical behaviours | Marks |
| * gives correct type of graph * identifies the two distinct sets as being represented by dots (or vertices) * identifies the meaning of the edges. | 1  1  1 |

**Question 8 (a) (5 marks)**

|  |  |
| --- | --- |
| Solution | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | 0 | 1 | 2 | 3 | 4 | 5 | | Population size (00’s) | 35 | 38 | 40.4 | 42.32 | 43.86 | 45.09 | | |
| Marking key/mathematical behaviours | Marks |
| * completes at least two correct table values * completes all table values correctly to 2 d.p. * plots at least 4 points correctly * plots all points correctly * recognises discrete term values therefore no line connecting points | 1  1  1  1  1 |

**Question 8 (b) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| Trend of population is increasing/growing, however, the growth rate is decreasing each time. | |
| Marking key/mathematical behaviours | Marks |
| * recognises growth * states growth rate is decreasing | 1  1 |

**Question 8 (c) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
| No, the relationship has a steady state solution of 5000, therefore never reaching the required 6000. | |
| Marking key/mathematical behaviours | Marks |
| * states no * identifies steady state solution * correctly states value of steady state solution | 1  1  1 |

**Question 9 (a) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| New annual interest rate | |
| Marking key/mathematical behaviours | Marks |
| * correctly determines * correctly converts answer to an annual interest rate | 1  1 |

**Question 9 (b) (5 marks)**

|  |  |
| --- | --- |
| Solution | |
| A = 1% of 38181.94 = 381.82 (2 d.p.)  B = 1000  C = 38181.94 + 381.82 – 1000 = 37563.76  D = 12.5% of 829.8425 = 10.37  E = 829.84 + 10.37 = 840.21 | |
| Marking key/mathematical behaviours | Marks |
| * correctly calculates 1% of 38181.94 * identifies constant repayment * calculates amount owing at the end of fourth month * correctly calculates 12.5% of 829.8425 * uses *D* with amount owing from Row *36* to calculate final payment | 1  1  1  1  1 |

**Question 9 (c) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
|  | |
| Marking key/mathematical behaviours | Marks |
| * correctly writes the recursive rule (uses rate and repayment) * correctly includes the initial term | 2  1 |

**Question 9 (d) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| Total repayments  Total interest paid | |
| Marking key/mathematical behaviours | Marks |
| * correctly calculates total amount repaid * correctly determines total interest paid | 1  1 |

**Question 10 (5 marks)**

|  |  |
| --- | --- |
| Solution | |
| Option 1:    Investment total  Option 2:    Option 3:    Therefore Option 2 is the best option to choose. | |
| Marking key/mathematical behaviours | Marks |
| * correctly calculates simple interest * correctly calculates value of investment with principal and interest * correctly calculates Option 2 using compound interest formula * correctly calculates Option 3 using compound interest formula * concludes that Option 2 is the best option based on calculations | 1  1  1  1  1 |

**Question 11 (a) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  | **A** | **B** | **C** | **D** | **E** | **F** | | **A** | - | 8.5 | 12.5 | - | 8.7 | - | | **B** | 8.5 | - | 7.6 | 6.2 | 4.5 | - | | **C** | 12.5 | 7.6 | - | 6.4 | - | 8.8 | | **D** | - | 6.2 | 6.4 | - | 5.8 | 3.1 | | **E** | 8.7 | 4.5 | - | 5.8 | - | 6.8 | | **F** | - | - | 8.8 | 3.1 | 6.8 | - | | |
| Marking key/mathematical behaviours | Marks |
| * correctly draws at least 3 edges * correctly draws minimum spanning tree | 1  1 |

**Question 11 (b) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
|  | |
| Marking key/mathematical behaviours | Marks |
| * calculates correct total distance of minimum spanning tree * calculates correct minimum cost of project | 1  1 |

**Question 11 (c) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| The minimum spanning tree would no longer include edge *DC*, and would have *BC* instead. This also changes total minimum cost. The total distance is increased by 1.2 metres at an extra cost of $1008. | |
| Marking key/mathematical behaviours | Marks |
| * identifies correct edge change * states correct increase of cost | 1  1 |

**Question 12 (a) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| A 7-point average would be the most appropriate, reflecting a weekly cycle. | |
| Marking key/mathematical behaviours | Marks |
| * indicates a 7-point average * makes the link with a weekly cycle | 1  1 |

**Question 12 (b) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| Trend appears to be gradually rising over time as reflected by rising minimum points in each cycle. The rise in the peaks of each cycle are not so clear but day 16 is higher that day 3, even if day 9 has a slight dip. | |
| Marking key/mathematical behaviours | Marks |
| * indicates a rising trend * gives a plausible explanation of how this has been decided | 1  1 |

**Question 12 (c) (4 marks)**

|  |  |
| --- | --- |
| Solution | |
| |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | Day number | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | | Price/litre | 127.5 | 125.9 | 121.0 | 130.4 | 131.0 | 131.1 | 130.4 | 129.0 | 126.9 | 123.8 | 131.5 |   The weekly mean for week 2, will be the average of the price for the 7 days as highlighted.  The percentage of the weekly mean for day 9 will be  The percentage of the weekly mean for day 10 will be | |
| Marking key/mathematical behaviours | Marks |
| * identifies the need to calculate the mean for week 2 (days 8-14) * calculates the weekly mean as 129.1 cents * calculates the correct % weekly mean for day 9 (to at least 1 d.p.) * calculates the correct % weekly mean for day 10 (to at least 1 d.p.) | 1  1  1  1 |

**Question 12 (d) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
|  | |
| Marking key/mathematical behaviours | Marks |
| * identifies the -intercept at ~129.3 * identifies at least one other point, eg (18,130.34) * draws the appropriate line | 1  1  1 |

**Question 12 (e) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| At  Given that the seasonal index for Wednesday is  The actual price per litre for day 25 | |
| Marking key/mathematical behaviours | Marks |
| * substitutes into the least-squares regression line for the moving avaerages. * applies the Wednesday index to calculate the actual value | 1  1 |

**Question 12 (f) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| The prediction is reliable as it is in the next cycle immediately after the end of the data used to calculate the least-squares regression line for the moving averages (4 days past the known data – but with the one cycle). | |
| Marking key/mathematical behaviours | Marks |
| * recognises prediction is reliable * recognises it is within the next cycle, even though 4 days out. | 1  1 |

**Question 13 (a) (4 marks)**

|  |  |
| --- | --- |
| Solution | |
| Total max flow | |
| Marking key/mathematical behaviours | Marks |
| * evidence of systematic approach * correctly lists at least 3 routes and corresponding flow * correctly lists all possible routes and corresponding flow * correctly states maximum flow of network | 1  1  1  1 |

**Question 13 (b) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
| Cut  Cut  Cut  Therefore the cut that supports max. flow of 400ppl/min is Cut | |
| Marking key/mathematical behaviours | Marks |
| * correctly calculate at least 2 cuts * correctly calculate all three cut totals * states Cut | 1  1  1 |

**Question 13 (c) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
| The upgrade will have no effect on maximum flow.  Lift location edge *EH* has not been entirely used and lift location *EF* has no flow leading in or out. | |
| Marking key/mathematical behaviours | Marks |
| * identifies lift locations * states no effect on max flow * provides correct reason | 1  1  1 |

**Question 14 (a) (4 marks)**

|  |  |
| --- | --- |
| Solution | |
| *v* = 8, *f* = 6, *e*= 12 and *v* + *f* – 2 = *e* i.e. 8 + 6 – 2 = 12 | |
| Marking key/mathematical behaviours | Marks |
| * identifies the number of faces, edges and vertices * verifies Euler’s rule applies | 3  1 |

**Question 14 (b) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| No, it is not a Eulerian graph.  A Eulerian graph is connected and traversable, starting and finishing at the same vertex. It must have no odd vertices. The given graph has 4 odd vertices (O, T, S and K). | |
| Marking key/mathematical behaviours | Marks |
| * identifies the graph as non-Eulerian. * Indicates a correct reason – i.e. it has 4 odd vertices | 1  1 |

**Question 14 (c) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
| The specified walk defines a closed circuit which is also a Hamiltonian cycle. The walk does not have any repeated vertices or edges and starts & ends at the same vertex | |
| Marking key/mathematical behaviours | Marks |
| * identifies the required walk * indicates a closed circuit/Hamiltonian cycle * identifies characteristics | 1  1  1 |

**Question 15 (a) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
| Therefore relationship is weak, positive, linear. | |
| Marking key/mathematical behaviours | Marks |
| * calculates correlation coefficient correctly to 4 d.p. * states there is a weak positive linear relationship between variables | 1  2 |

**Question 15 (b) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| Explanatory variable = height  Response variable = mass | |
| Marking key/mathematical behaviours | Marks |
| * correctly identifies explanatory variable * correctly identifies response variable | 1  1 |

**Question 15 (c) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
|  | |
| Marking key/mathematical behaviours | Marks |
| * correctly determines gradient * correctly determines -intercept | 1  1 |

**Question 15 (d) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
| This value suggests that 27.34% of the change in mass can be attributed to the change in height.  Since 27.34% is a low percentage, a linear model may not be appropriate. | |
| Marking key/mathematical behaviours | Marks |
| * correctly calculates coefficient of determination * correctly explain significance of the coefficient of determination * clearly states that a linear model may not be appropriate for these data | 1  1  1 |

**Question 15 (e) (4 marks)**

|  |  |
| --- | --- |
| Solution | |
| Prediction is reliable as it involves interpolation    Prediction is unreliable as it involves extrapolation | |
| Marking key/mathematical behaviours | Marks |
| * correctly calculates predicted value for *h* = 182 * concludes prediction for *h* = 182 is reliable due to interpolation * correctly calculates predicted value for *h* = 200 * concludes prediction for *h* = 200 is unreliable due to extrapolation | 1  1  1  1 |

**Question 16 (a) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
|  | |
| Marking key/mathematical behaviours | Marks |
| * has U, V and Z coming out from T * completes network with correct edges * edges have correct labels (task and duration) | 1  1  1 |

**Question 16 (b) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| Critical path is  Minimum completion time is 15 days | |
| Marking key/mathematical behaviours | Marks |
| * states the correct critical path * calculates correct minimum completion time | 2  2 |

**Question 16 (c) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| 1. float time for task Z = 0 as on critical path 2. task W has a float time of 7 days, so the latest start date is 7 days (1 week) | |
| Marking key/mathematical behaviours | Marks |
| * correctly states there is no float time for Task Z * correctly determines latest start time | 1  1 |

**Question 16 (d) (3 marks)**

|  |  |
| --- | --- |
| Solution | |
| Critical path is now  and the minimum completion time has been increased by 2 days | |
| Marking key/mathematical behaviours | Marks |
| * correctly states new critical path * identifies increase in completion time * states increase of 2 days | 1  1  1 |

**Question 17 (a) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| Third year  Fourth year | |
| Marking key/mathematical behaviours | Marks |
| * calculates the amount withdrawn in third year * calculates the amount withdrawn in fourth year | 1  1 |

**Question 17 (b) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| Using a spreadsheet or sequence function (or otherwise), the amount left in the annuity after the 10th withdrawal is $244090.48 | |
| Marking key/mathematical behaviours | Marks |
| * uses an appropriate method * correctly calculates the amount remaining after the 10th withdrawal | 1  1 |

**Question 17 (c) (2 marks)**

|  |  |
| --- | --- |
| Solution | |
| Using a spreadsheet or sequence function (or otherwise), it will take 17 years for the annuity to reach a balance of 0 (after 16 withdrawals there is only 5897.61 remaining) | |
| Marking key/mathematical behaviours | Marks |
| * correctly calculates the number of years for the annuity to reach a balance of 0. | 2 |