

MATHEMATICS APPLICATIONS

MAWA Semester 1 (Unit 3) Examination 2019

Calculator-Assumed

Marking Key

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The release date for this exam and marking scheme is 14th June.

Section Two: Calculator-assumed

(100 Marks)

Question 7 (a)

(2 marks)

Solution	
$\frac{ar^7}{ar^2} = 32$ $r = 2$ $\therefore \text{the first four terms are } 2, 4, 8, 16$	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> determines value of r 	1
<ul style="list-style-type: none"> states the first four terms 	1

Question 7 (b)

(2 marks)

Solution	
$n = 0, T_2 = T_1 - 0^2 = 15$ $n = 1, T_3 = T_2 - 1^2 = 14$ $n = 2, T_4 = T_3 - 2^2 = 10$ $\therefore \text{the first four terms are } 15, 15, 14, 10$	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> determines terms 2,3,4 using the n^{th} term formula by substituting values of n 	1
<ul style="list-style-type: none"> states the first four terms 	1

Question 7 (c)

(3 marks)

Solution															
(i)															
<table border="1"> <thead> <tr> <th>n</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> </tr> </thead> <tbody> <tr> <td>T_n</td> <td>3</td> <td>3.75</td> <td>4.5</td> <td>5.25</td> <td>6</td> <td>6.75</td> </tr> </tbody> </table>		n	1	2	3	4	5	6	T_n	3	3.75	4.5	5.25	6	6.75
n	1	2	3	4	5	6									
T_n	3	3.75	4.5	5.25	6	6.75									
$4T_{n-1} = 4T_n - 3, T_1 = 3$ $4T_1 = 4T_2 - 3$ $12 = 4T_2 - 3$ $T_2 = 3.75$															
(ii) A common difference of 0.75 exists, sequence is an A.P.															
Marking key/mathematical behaviours	Marks														
<ul style="list-style-type: none"> completes all entries correctly 	2														
<ul style="list-style-type: none"> identifies sequence as an A.P 	1														

Question 8 (a)&(b)

(3 marks)

Solution			
Population statistics for Australia and Western Australia 2008 and 2018			
		Jun-08	Jun-18
Australia	Males	10572045	12397898
	Females	10677154	12594471
	Total	21249199	24992369
Western Australia	Males	1094894	1298288
	Females	1076206	1297589
	Total	2171100	2595877
<p>(a) numbers 21249199 and 12494471 are arrived at by calculator addition and subtraction respectively.</p> <p>(b) The number for females in WA in 2008 is incorrect. Seems too small and the number of males and females don't sum to the total given, which does seem reasonable. Number of females should be 1076206</p>		<div style="font-family: monospace; font-size: 0.9em;"> $10572045+10677154$ 21249199 $24992369-12397898$ 12594471 $2171100-1094894$ 1076206 </div>	
Marking key/mathematical behaviours			Marks
<ul style="list-style-type: none"> • states the two correct numbers • identifies the number of females in WA for 2008 as incorrect and provides a plausible explanation as to why • states the correct number of females (1076206) 			<p>1</p> <p>1</p> <p>1</p>

Question 8 (c)

(4 marks)

Solution																							
<p>(i) $\frac{1298288}{2595877} \times 100 = 50.01\%$ (to two dec. pls)</p> <p>(ii)</p>	<div style="border: 1px solid black; padding: 5px; margin-bottom: 10px;"> $\frac{1298288}{2595877} * 100$ <p style="text-align: right;">50.01346366</p> </div> <table border="1" style="width: 100%; border-collapse: collapse; margin-bottom: 10px;"> <thead> <tr> <th colspan="4" style="text-align: center;">Population percentages for Australia and Western Australia 2008 and 2018</th> </tr> <tr> <th></th> <th></th> <th>Jun-08</th> <th>Jun-18</th> </tr> </thead> <tbody> <tr> <td rowspan="2" style="text-align: center;">Australia</td> <td>Males</td> <td style="text-align: center;">49.75%</td> <td style="text-align: center;">49.61%</td> </tr> <tr> <td>Females</td> <td style="text-align: center;">50.25%</td> <td style="text-align: center;">50.39%</td> </tr> <tr> <td rowspan="2" style="text-align: center;">Western Australia</td> <td>Males</td> <td style="text-align: center;">50.43%</td> <td style="text-align: center;">50.01%</td> </tr> <tr> <td>Females</td> <td style="text-align: center;">49.57%</td> <td style="text-align: center;">49.99%</td> </tr> </tbody> </table>	Population percentages for Australia and Western Australia 2008 and 2018						Jun-08	Jun-18	Australia	Males	49.75%	49.61%	Females	50.25%	50.39%	Western Australia	Males	50.43%	50.01%	Females	49.57%	49.99%
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	Females	49.57%	49.99%																				
Marking key/mathematical behaviours	Marks																						
<p>(i)</p> <ul style="list-style-type: none"> • uses the correct numbers • shows the division and multiplies by 100 <p>(ii)</p> <ul style="list-style-type: none"> • states at least two of the correct %'s • calculates all the %'s correctly 	<p>1</p> <p>1</p> <p>1</p> <p>1</p>																						

Question 8 (d)

(2 marks)

Solution	
<p>In Australia, the proportion of males decreased over time (over the decade 08-18) whilst the proportion of females increased.</p> <p>In Western Australia, the proportion of males is higher than the proportion of females, however, for Australia as a whole, the reverse is true.</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> • states an association of variables, eg. proportion of M/F's over time or proportion of M/F between Australia and WA etc. • interprets what the association is indicating eg. Increasing/decreasing 	<p>1</p> <p>1</p>

Question 8 (e)

(1 mark)

Solution	
<p>Because we are able to make proportional comparisons which are more helpful than array's of large numbers for making comparisons.</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> • identifies/refers to use of proportional comparisons 	<p>1</p>

Question 9 (a)

(3 marks)

Solution	
Must finish at vertex C One example of trail: <i>Office</i> – $A - B - F - A - C - D - H - E - G - F - E - D - J - C$ or another permutation that covers every edge once only, starting at the office ending at vertex C .	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states trail ends at vertex C 	1
<ul style="list-style-type: none"> completes an open trail 	1
<ul style="list-style-type: none"> correctly states a Semi-Eulerian trail 	1

Question 9 (b)

(3 marks)

Solution	
(i) <i>Office</i> – $A - B - F - G - E - H - D - J - C$ OR <i>Office</i> – $A - C - J - D - H - E - G - F - B$ (ii) Hamiltonian Trail (or Semi-Hamiltonian)	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> describes a route starting at the office with no classroom repetitions 	1
<ul style="list-style-type: none"> correctly states route 	1
<ul style="list-style-type: none"> states Hamiltonian Trail or Semi-Hamiltonian 	1

Questions 9 (c)

(2 marks)

Solution	
No, it is no longer possible as classroom E or F would have to be revisited.	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states no 	1
<ul style="list-style-type: none"> identifies repetition of vertices 	1

Question 10 (a)

(2 marks)

Solution	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> correctly draw at least 4 edges 	1
<ul style="list-style-type: none"> correctly draw all edges 	1

Question 10 (b)

(4 marks)

Solution	
$ \begin{array}{c} A \quad B \quad C \quad D \\ M^2 = \begin{array}{l} A \begin{bmatrix} 2 & 1 & 2 & 1 \end{bmatrix} \\ B \begin{bmatrix} 1 & 3 & 2 & 0 \end{bmatrix} \\ C \begin{bmatrix} 2 & 2 & 3 & 1 \end{bmatrix} \\ D \begin{bmatrix} 1 & 0 & 1 & 1 \end{bmatrix} \end{array} \end{array} $	
(ii) The zero elements indicate there are no two-edge routes between Town B and D	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states at least 12 correct element entries 	1
<ul style="list-style-type: none"> correctly states all entries 	1
<ul style="list-style-type: none"> identifies that the zero signifies no two-step routes 	1
<ul style="list-style-type: none"> correctly identifies Town B and D 	1

Question 10 (c)

(4 marks)

Solution	
Yes, the graph is planar	
$ \begin{array}{l} v = 4 \\ e = 5 \\ f = 3 \end{array} $	$ \begin{array}{l} LHS = v + f - e \\ = 4 + 3 - 5 \\ = 2 \\ = RHS \therefore \text{verified} \end{array} $
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states yes 	1
<ul style="list-style-type: none"> correctly states number of faces, vertices and edges 	1
<ul style="list-style-type: none"> correctly substitutes values into Euler's formula 	1
<ul style="list-style-type: none"> verifies left hand-side equals right-hand side 	1

Question 11 (a)

(1 mark)

Solution	
The AUS/USD exchange rate	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> identifies the AUS/USD as the explanatory variable 	1

Question 11 (b)

(3 marks)

Solution	
<p>TWI</p> <p>AUS/USD exchange rate</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> plots one of the missing points correctly plots the second of the missing points correctly labels the axes correctly 	1 1 1

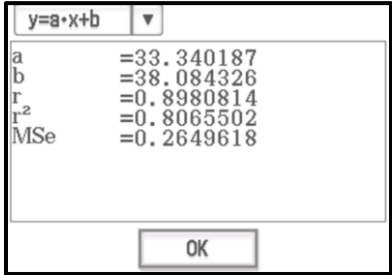
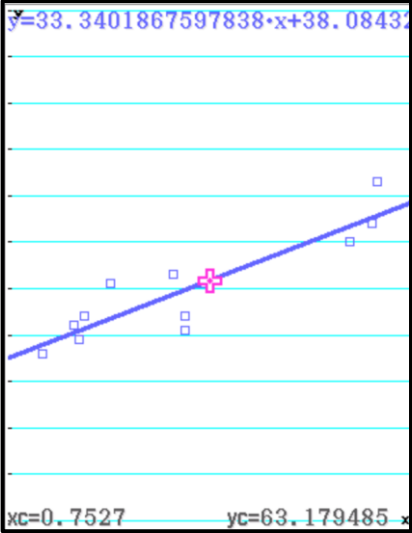
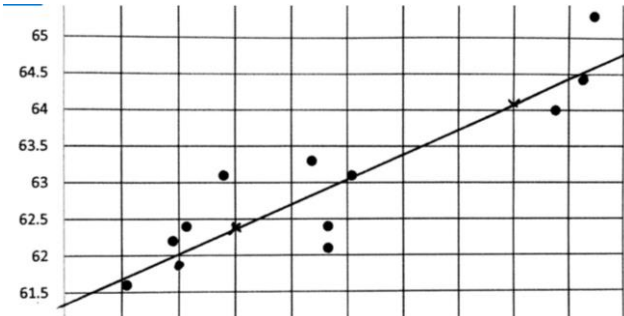
Question 11 (c)

(3 marks)

Solution																																																					
<p>(i) enter the data</p> <p>Set calculation menu on calculator for linear regression and read off $r = 0.8981$ to 4 decimal places.</p> <table border="1"> <thead> <tr> <th></th> <th>list1</th> <th>list2</th> <th>list3</th> </tr> </thead> <tbody> <tr><td>1</td><td>0.7946</td><td>65.3</td><td></td></tr> <tr><td>2</td><td>0.7933</td><td>64.4</td><td></td></tr> <tr><td>3</td><td>0.7876</td><td>64</td><td></td></tr> <tr><td>4</td><td>0.7508</td><td>63.1</td><td></td></tr> <tr><td>5</td><td>0.7465</td><td>62.1</td><td></td></tr> <tr><td>6</td><td>0.7465</td><td>62.4</td><td></td></tr> <tr><td>7</td><td>0.7436</td><td>63.3</td><td></td></tr> <tr><td>8</td><td>0.7213</td><td>62.4</td><td></td></tr> <tr><td>9</td><td>0.72</td><td>61.9</td><td></td></tr> <tr><td>10</td><td>0.7108</td><td>61.6</td><td></td></tr> <tr><td>11</td><td>0.7279</td><td>63.1</td><td></td></tr> <tr><td>12</td><td>0.7189</td><td>62.2</td><td></td></tr> </tbody> </table>		list1	list2	list3	1	0.7946	65.3		2	0.7933	64.4		3	0.7876	64		4	0.7508	63.1		5	0.7465	62.1		6	0.7465	62.4		7	0.7436	63.3		8	0.7213	62.4		9	0.72	61.9		10	0.7108	61.6		11	0.7279	63.1		12	0.7189	62.2		
	list1	list2	list3																																																		
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<p>(ii) The scatter plot indicates a strong positive linear correlation, since the TWI reading increases as the AUS/USD exchange rate increases. This is reflected in the high correlation coefficient of ~ 0.9</p>																																																					
Marking key/mathematical behaviours	Marks																																																				
<ul style="list-style-type: none"> states $r = 0.8981$ comments on the strength, direction and linearity of the scatter plot from the graph. 	1 1																																																				

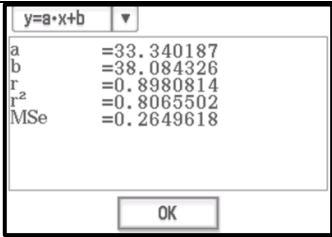
<ul style="list-style-type: none"> links the comment (above) to the TWI and AUS/USD exchange rate to the value of $r = 0.8981$ 	1
--	---

Question 11 (d) **(4 marks)**

Solution	
<p>(i) $y = 33.3x + 38.1$ (a and b given to one decimal places).</p> <p>hence the gradient of the line $m = 33.3$</p>	 
<p>(ii) Calculate two points using the equation in (i) e.g. (0.73, 62.4) and (0.78, 64.1) Plot these two points and draw the line.</p>	
	

Marking key/mathematical behaviours	Marks
<p>(i)</p> <ul style="list-style-type: none"> states the correct least-squares equation of the line states the gradient of the line correct to 1 decimal place. 	1 1
<p>(ii)</p> <ul style="list-style-type: none"> calculates two points on the line (that are correct based on (i)) draws the lines passing through the two calculated point, plotted accurately 	1 1

Question 11 (e) **(2 marks)**

Solution	
<p>The coefficient of determination $R^2 = (0.8981)^2 = 0.806584$ Or more accurately, from the calculator $R^2 = 0.8066$ (to 4 decimal places) The coefficient of determination tells us that approximately 80% of the variation in the AUS/USD exchange rate is associated with the variation in the TWI.</p>	

Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states the correct coefficient of determination (by either method) 	1
<ul style="list-style-type: none"> gives a statement that indicates understanding of the strength of the association in terms of variation. 	1

Question 11 (f)

(2 marks)

Solution	
<p>The TWI of the 13th month will be $= 33.3 \times 0.723 + 38.1 = 62.18$ (to two decimal places) This should be reasonably reliable (since the association is strong) providing that there are no confounding events that affect the association between the two variables, as it is a prediction into the future.</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> • determines the TWI correctly 	1
<ul style="list-style-type: none"> • provides an appropriate comment consistent with the strength of the association in the past, while acknowledging the possibility of changing into the future. 	1

Question 12 (a)

(3 mark)

Solution	
<p>The shortest route is $A-G-F-C-D-E$, with a time of 30 minutes</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> • identifies shortest route on graph • states route • sums edges to calculate travel time 	<p>1</p> <p>1</p> <p>1</p>

Question 12 (b)

(3 mark)

Solution	
<p>Shortest route is no longer available. Alternate route of $A-B-C-D-E$ takes 1 minute longer (31 minutes).</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> • states time travelled will increase • identifies new shortest route • calculates new time taken 	<p>1</p> <p>1</p> <p>1</p>

Question 13 (a)

(1 mark)

Solution	
A decrease of 20% of alpacas at the end of each year	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> identifies there is a decrease 	1

Question 13 (b)

(2 marks)

Solution	
5 alpacas are added each year	
$A_n = 0.8A_{n-1} + 12 - 7$	
$A_n = 0.8A_{n-1} + 5$	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states 5 alpacas 	1
<ul style="list-style-type: none"> simplifies the recursive rule correctly to show "5" is added 	1

Question 13 (c)

(2 marks)

Solution	
$20 = 0.95(20) + k$	
$\therefore k = 1$	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> substitutes $A_n = A_{n-1} = 20$ 	1
<ul style="list-style-type: none"> solves for "k" correctly 	1

Question 14 (a)

(1 mark)

Solution	
Since the coefficient of determination is given as 0.8577, the percentage of the variation will be 85.77%.	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> uses the coefficient of determination to state the correct percentage 	1

Question 14 (b)

(1 mark)

Solution	
By substitution into the predicted fair value formula given, $A = 30.2$ and $B = 29.3$	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states the correct resale values 	1

Question 14 (c)

(2 marks)

Solution	
By subtraction, $C = -0.3$ and $D = -1.85$	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states the correct values for C and D (allow follow through if B was not correct in part (b)). 	2

Question 14 (d)

(2 marks)

Solution																							
<p>The residual plot shows the following approximate data points:</p> <table border="1"> <thead> <tr> <th>Kilometres (k)</th> <th>Residual</th> </tr> </thead> <tbody> <tr><td>5</td><td>1.9</td></tr> <tr><td>7</td><td>1.6</td></tr> <tr><td>10</td><td>-0.6</td></tr> <tr><td>13</td><td>0.6</td></tr> <tr><td>15</td><td>1.3</td></tr> <tr><td>17</td><td>-0.5</td></tr> <tr><td>20</td><td>0.3</td></tr> <tr><td>25</td><td>-0.9</td></tr> <tr><td>30</td><td>-0.2</td></tr> <tr><td>35</td><td>-1.8</td></tr> </tbody> </table>		Kilometres (k)	Residual	5	1.9	7	1.6	10	-0.6	13	0.6	15	1.3	17	-0.5	20	0.3	25	-0.9	30	-0.2	35	-1.8
Kilometres (k)	Residual																						
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20	0.3																						
25	-0.9																						
30	-0.2																						
35	-1.8																						
Marking key/mathematical behaviours	Marks																						
<ul style="list-style-type: none"> plots at least two of the point correctly 	1																						
<ul style="list-style-type: none"> plots all points correctly 	1																						

Question 14 (e)

(1 mark)

Solution	
The residuals are roughly half positive and half negative. (However, they are not really randomly dispersed, which does indicate that a better model, other than a linear one may be possible).	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none">Indicates that the residuals are spread equally above and below the horizontal axis	1

Question 15 (a)

(4 marks)

Solution	
(i)	<p>City Party: Bec, Charlie and Gillian Beach Party: Dean, Alice, Emma and Frank</p>
(ii)	5 edges required to make graph complete
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> correctly identifies friends for each party completes at least 5 edges correctly correctly completes all edges recognises and states correct number of extra edges needed 	<p>1</p> <p>1</p> <p>1</p> <p>1</p>

Question 15 (b)

(3 marks)

Solution	
(i)	
(ii)	K_5 is not planar as you are unable to redraw it without any edges crossing each other
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> correctly draws at least 8 edges correctly draws all edges refers to inability to uncross all edges 	<p>1</p> <p>1</p> <p>1</p>

Question 15 (c)

(2 marks)

Solution	
$e = \frac{n(n-1)}{2}$ $78 = \frac{n(n-1)}{2}$ <p>Solve using CAS</p>	<p>Equation:</p> $e = \frac{n \cdot (n-1)}{2}$ <p><input type="radio"/> e = 78</p> <p><input checked="" type="radio"/> n = 13</p>
<p>$n = 13 \therefore 13$ teams in rugby tournament</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> identified formula correctly solves for 13 teams 	<p>1</p> <p>1</p>

Question 16 (a)

(3 marks)

<p>AP: $d = 575 - 500 = 75$ $d = 646 - 575 = 71$ $d = 714 - 646 = 68$</p> <p>Since there is no common difference, $d \therefore$ not an A.P.</p> <p>GP: $r = \frac{575}{500} = 1.15$ $r = \frac{646}{575} = 1.12$ $r = \frac{714}{646} = 1.11$</p> <p>Since a common ration, r does not exists, \therefore not a G.P.</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> calculates at least two "d" values 	1
<ul style="list-style-type: none"> calculates at least two "r" values 	1
<ul style="list-style-type: none"> states conclusion 	1

Question 16 (b)

(2 marks)

Solution	
<p>(i) there is a 5% decrease in the population at the end of each year (ii) 100 new people moved into the town at the end of each year</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states a decrease in population 	1
<ul style="list-style-type: none"> states an additional 100 new people move into town 	1

Question 16 (c)

(1 marks)

Solution	
Population in 2018 is 1005	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> determines correct population 	1

Question 16 (d)

(2 marks)

Solution	
<p>Let maximum population be x. $x = 0.95x + 100$ $x = 2000$ \therefore the maximum population is 2000</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> identifies steady state reaches 2000 	1
<ul style="list-style-type: none"> use algebra correctly to find the steady state 	1

Question 17 (a)

(2 marks)

Solution	
<p>Create a few survey questions and ask drivers within the school community to complete the survey. This could include, student drivers, parent drivers and teachers. Source data already collected and published by other local organisations such as the national driver safety council, the police force or RAC etc.</p>	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> provides an example of direct (or primary) data collection such as a survey 	1
<ul style="list-style-type: none"> provides an example of a secondary source for the data 	1

Question 17 (b)

(2 marks)

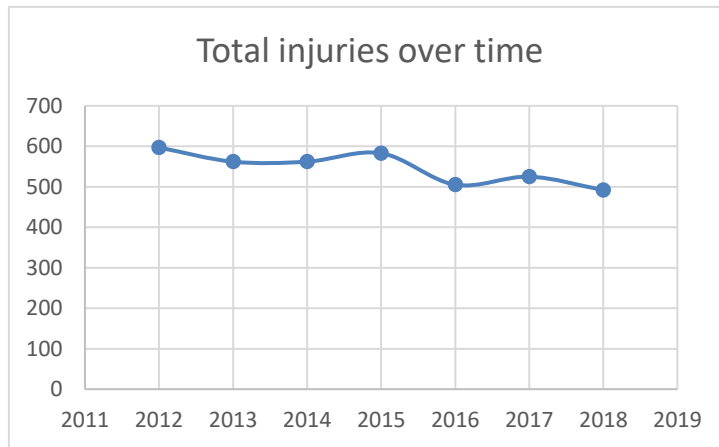
Solution															
<p>The number of serious injuries is correlated positively with the number of minor injuries. This is obvious from the scatter plot below.</p>															
<table border="1" style="margin: auto;"> <caption>Data points from the scatter plot</caption> <thead> <tr> <th>Serious Injuries (X)</th> <th>Minor Injuries (Y)</th> </tr> </thead> <tbody> <tr> <td>50</td> <td>445</td> </tr> <tr> <td>52</td> <td>455</td> </tr> <tr> <td>55</td> <td>465</td> </tr> <tr> <td>65</td> <td>495</td> </tr> <tr> <td>75</td> <td>485</td> </tr> <tr> <td>78</td> <td>515</td> </tr> </tbody> </table>		Serious Injuries (X)	Minor Injuries (Y)	50	445	52	455	55	465	65	495	75	485	78	515
Serious Injuries (X)	Minor Injuries (Y)														
50	445														
52	455														
55	465														
65	495														
75	485														
78	515														
Marking key/mathematical behaviours	Marks														
<ul style="list-style-type: none"> provides an association based on the data 	1														
<ul style="list-style-type: none"> provides appropriate descriptive or graphical explanation/reasoning 	1														

Question 17 (c)

(2 marks)

Solution

The total number of injuries (and each of the sub categories) shows a gradual decreasing trend over the decade. See below.



It would be helpful to have the population number for each of the given years, so that proportional data could be compared rather than absolute numbers. For example, if the population concerned is increasing over the decade (which is likely) then what appears to be a weak declining trend could be more significant in proportional terms.

Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> suggests relevant additional data (e.g. population) 	1
<ul style="list-style-type: none"> explains how this would be helpful (e.g. allowing proportional comparison) 	1

Question 18 (a)

(2 marks)

Solution	
$M_{n+1} = M_n + 5, M_1 = 50$	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> states recursive rule correctly 	1
<ul style="list-style-type: none"> states the first term 	1

Question 18 (b)

(3 marks)

Solution	
$M_n = 50 + 5(n-1)$	
$M_n = 45 + 5n$	
Now $200 = 45 + 5n$	
$n = 31$	
∴ it takes Julie 31 months to pay off the interest free loan	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> determines the nth term formula 	1
<ul style="list-style-type: none"> substitutes 200 into the formula and solve for n correctly 	1
<ul style="list-style-type: none"> states correct number of months 	1

Question 18 (c)

(1 marks)

Solution	
From CAS total amount loaned to Julie was \$3875	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> determines correct total amount from CAS 	1

Question 18 (d)

(2 marks)

Solution	
(i) Use $T_{n+1} = T_n + 10, T_1 = 35$ and Total amount loaned as \$3875, $n = 25$ months	
(ii) $T_{25} = 275$	
Marking key/mathematical behaviours	Marks
<ul style="list-style-type: none"> determines correct answer 	1
<ul style="list-style-type: none"> determines correct answer 	1