TRINITY COLLEGE

Mathematics Applications Units 3 & 4
Test 3 2018

Section 1 Calculator Free

Time Series Data

STUDENT'S NAME MARKING KEY.

DATE: Thursday 17th May **TIME:** 15 minutes **MARKS**: 14

INSTRUCTIONS:

Standard Items: Pens, pencils, drawing templates, eraser

Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

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1. (3 marks)

Below are three cycles of a set of time series data with the 3 point moving averages calculated.

Period	Value	3 point MA
1	502	
2	613	524
3	458	513
4	467	552
5	580	487
6	415	471
7	418	457
8	537	450
9	394	

One moving average appears to be calculated incorrectly.

(a) On the table indicate clearly which moving average appears to be incorrect. [1]

(b) Write down the correct calculation for the value indicated in part (a). [2]

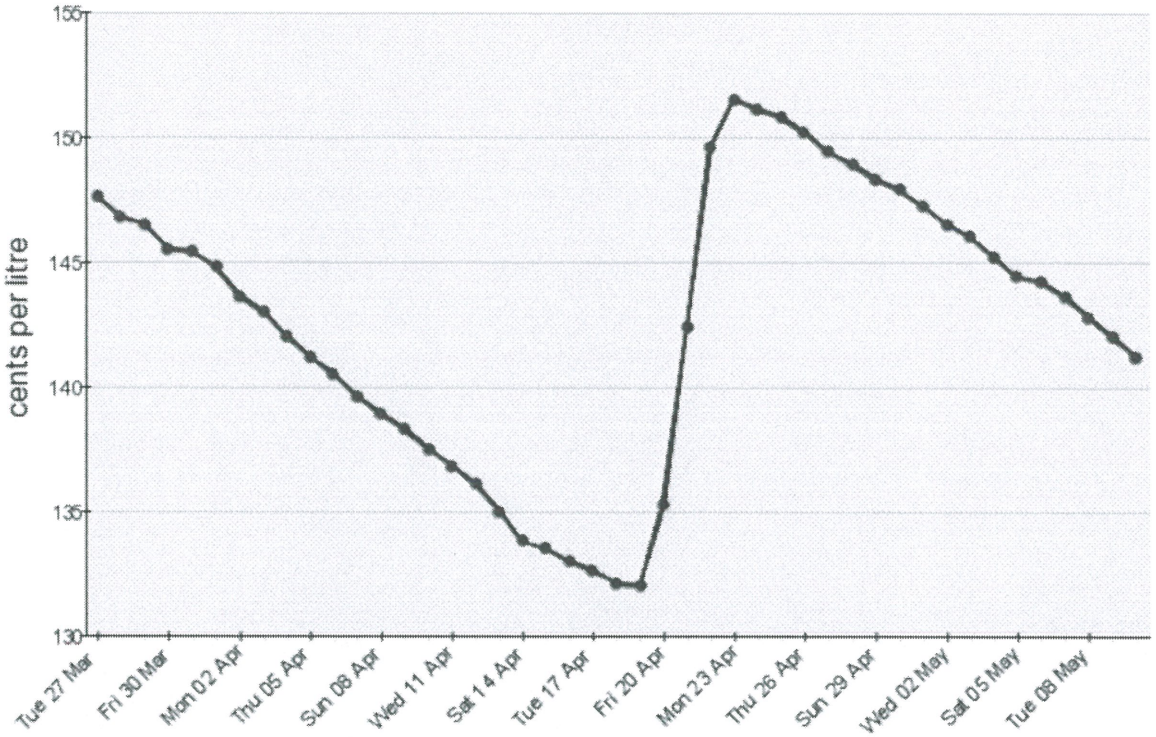
$$\frac{458 + 467 + 580}{3}$$ ✓✓

2. (6 marks)

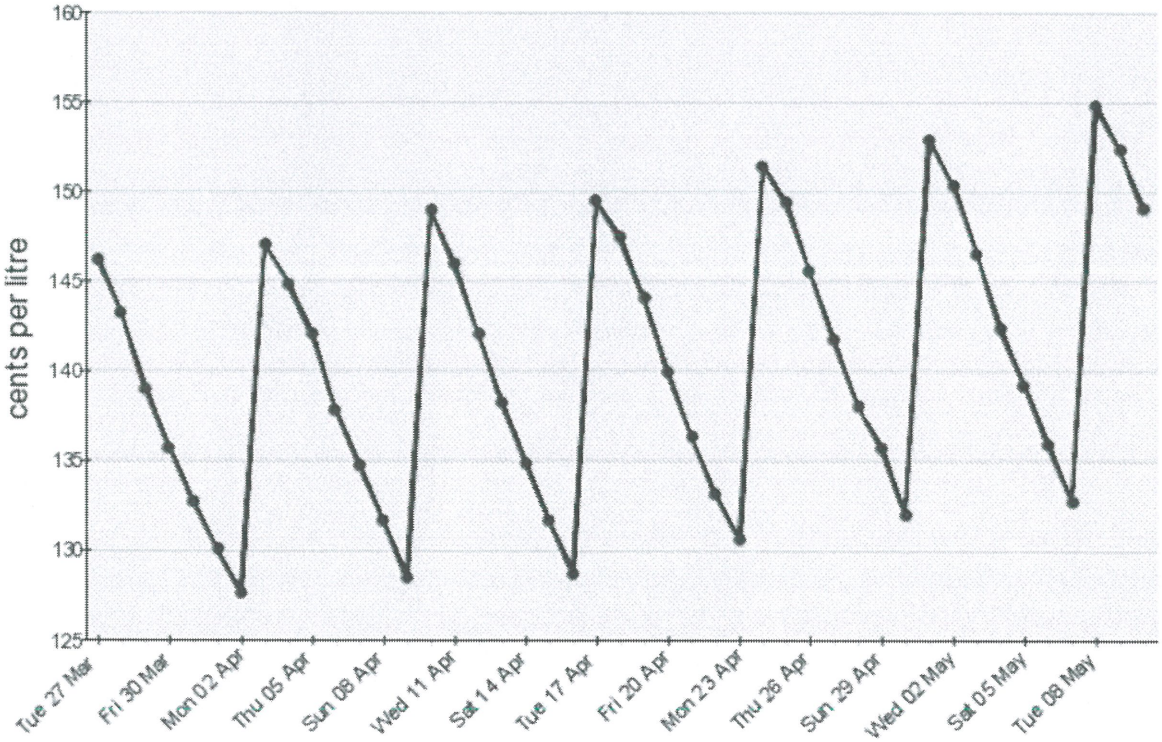
Below are the average prices, in cents per litre, of unleaded petrol in Melbourne and Perth from the 27th March 2018 to 10th May 2018.

[Source: Australia Competition & Consumer Commission]

Melbourne



Perth



(a) Are both graphs examples of time series data? Justify your answer. [2]

Yes, they are both plotted over a period of time.

(b) State the length of the cycle of the Perth data and give a possible reason for this. [2]

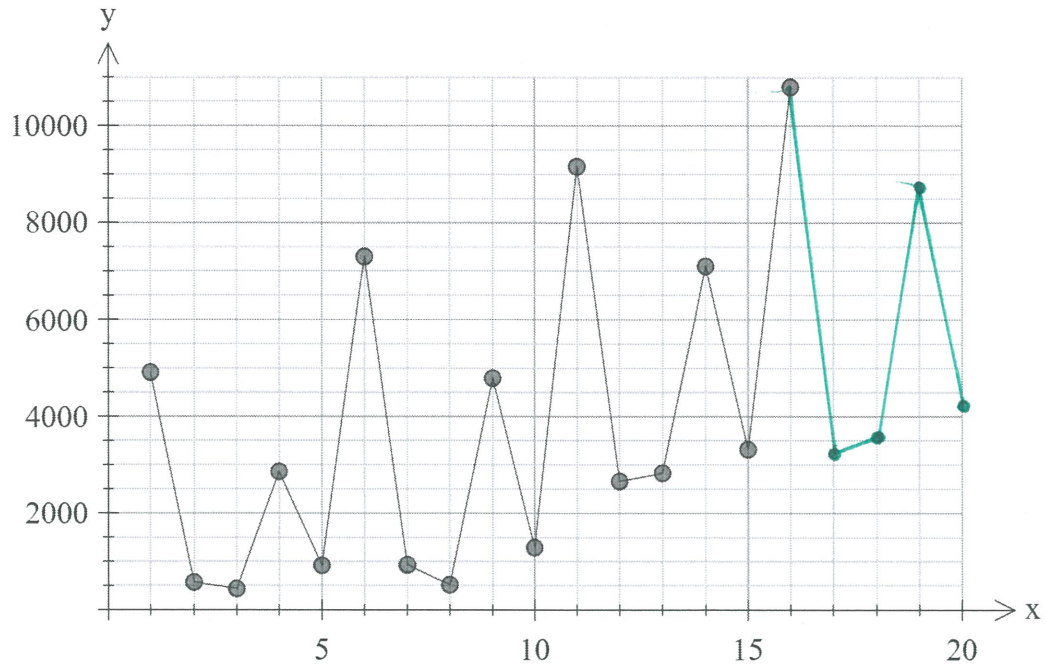
7 days, follows the days of the week.

(c) Give two reasons why it is difficult to comment on the overall trend for the Melbourne data. [2]

- Not enough data.
- Cannot tell if there is a cycle.

3. (5 marks)

Below is an example of an incomplete time series graph with a cyclic component.



The final four points of the graph are as follows;

x	17	18	19	20
y	3250	3510	8700	4090

(a) Add the final four data points to the graph above and connect them to the existing points. [2]

points correctly plotted ✓ connected points ✓

(b) State the length of the cycle. [1]

5 points ✓

(c) Comment on the overall trend of the data. [1]

Increasing ✓

(d) Suggest a possible context for the data that produces the graph shown. [1]

e.g. Calls to a call centre per week day. ✓

Any other valid response.

TRINITY COLLEGE

Mathematics Applications Units 3 & 4
Test 3 2018

Section 2 Calculator Assumed

Time Series Data

STUDENT'S NAME MARKING KEY.

DATE: Thursday 17th May **TIME:** 35 minutes **MARKS**: 38

INSTRUCTIONS:

Standard Items: Pens, pencils, drawing templates, eraser

Special Items: Three calculators, notes on one side of a single A4 page (these notes to be handed in with this assessment)

Questions or parts of questions worth more than 2 marks require working to be shown to receive full marks.

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4. (4 marks)

Below is an incomplete table showing the Centred Moving Averages for a set of 6 pieces of data. Calculate all possible Centred Moving Averages missing from the table below, given the information provided and indicate clearly where no values are possible.

	Centred Moving Averages				
n	**Value**	**3 Point CMA**	**4 Point CMA**	**5 Point CMA**	**6 Point CMA**
1	12.3	–	–	–	–
2	14.2	14.1	–	–	–
3	15.7	14.6	13.8	13.4	–
4	13.8	13.5	13.4	13.3	–
5	11.1	12.3	–	–	–
6	11.9	–	–	–	–

5. (16 marks)

A student downloaded the total rainfall, in mm per month, from the bureau of meteorology website for December 2014 to December 2017, shown below.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2014	-	-	-	-	-	-	-	-	-	-	-	0.2
2015	0.4	28.4	22.0	56.0	68.8	100.2	98.8	102.8	46.8	19.2	17.4	17.4
2016	23.4	0.8	21.4	61.6	106.0	86.4	129.4	131.6	61.8	37.8	5.6	8.6
2017	39.8	89.8	19.8	0.0	57.0	54.8	181.8	149.2	81.2	26.0	1.8	28.2

They decided to use this data to predict the rainfall for each season of 2018 by calculating the season total, yearly average and seasonal effect, shown below.

Note:

Season	Months
Summer	December, January and February
Autumn	March, April and May
Winter	June, July and August
Spring	September, October and November

t	Season	Year	Season Total	Cycle Mean	Seasonal Effect
1	Summer	2014/2015	29.0		0.2068
2	Autumn		146.8	*B*	1.0467
3	Winter		*A*		2.1519
4	Spring		83.4		0.5947
5	Summer	2015/2016	41.6		0.2436
6	Autumn		189.0	170.8	*C*
7	Winter		347.4		2.0340
8	Spring		105.2		*D*
9	Summer	2016/2017	132.2		0.7513
10	Autumn		76.8	175.95	0.4365
11	Winter		385.8		2.1927
12	Spring		109.0		0.6195

(a) Determine the values for A, B, C and D from the table. [4]

$A = 301.8$ ✓

$C = \frac{189.0}{170.8} = 1.1066$ ✓ *or 1.1065

$B = \frac{29 + 146.8 + 301.8 + 83.4}{4}$

$= 140.25$ ✓

$D = \frac{105.2}{170.8} = 0.6159$ ✓ *or 0.6158

(b) Calculate the seasonal index of each season and enter them in the table below. [4]

Summer	Autumn	Winter	Spring
0.4006	0.8633	2.1262.	0.6100
✓	✓	✓	✓

(c) The equation of least squares regression for the deseasonalised values (d) over time (t) is $d = 7.0547t + 117.385$. Predict the rainfall for the following seasons in 2017/2018.

(i) Summer $t = 13$ ✓ [3]

$d = 7.0547(13) + 117.385$

$= 209.0961$ ✓

209.0961×0.4006

$= 83.76$ ✓

≈ 83.8 mm

(ii) Winter $t = 15$ ✓ [3]

$d = 7.0547(15) + 117.385$

$= 223.2055$ ✓

223.2055×2.1262

$= 474.58$ ✓

≈ 474.6 mm

(d) Could either of the predictions from part (c) be considered more accurate than the other? Justify your answer. [2]

Winter ✓ is more accurate as there is a more consistant seasonal effect. ✓

6. (13 marks)

A graph of a restaurants profits over the first three weeks of January is shown below. The data has been smoothed by using moving averages and seasonal indices.

Note: Some of the data is missing.

Week	Day	*t*	Profit ($1000s)	Smoothed Data 1	Smoothed Data 2
1	Tue	1	1.28	1.12	
	Wed	2	1.31	1.16	
	Thurs	3	0.27	0.69	
	Fri	4	1.50	1.08	1.07
	Sat	5	2.10	1.09	1.05
	Sun	6	0.04	0.48	1.06
2	Tue	7	1.15	1.01	1.07
	Wed	8	1.17	1.03	1.06
	Thurs	9	0.51	1.30	1.05
	Fri	10	1.42	1.03	1.04
	Sat	11	1.98	1.03	1.02
	Sun	12	0.06	0.72	1.00
3	Tue	13	1.08	0.95	0.99
	Wed	14	1.01	0.89	0.97
	Thurs	15	0.42	1.07	0.95
	Fri	16	1.33	0.96	
	Sat	17	1.85	0.96	
	Sun	18	-0.01	-0.12	

(a) (i) Which column represents the 7 point moving average? [1]

Smoothed Data 2 ✓

(ii) Which column represents the seasonally adjusted data? [1]

Smoothed Data 1 ✓

Some of the seasonal indices are given below.

Tues	Wed	Thurs	Fri	Sat	Sun
1.1399	1.1308	0.3932	1.3815	1.9266 or 1.9223	0.0833

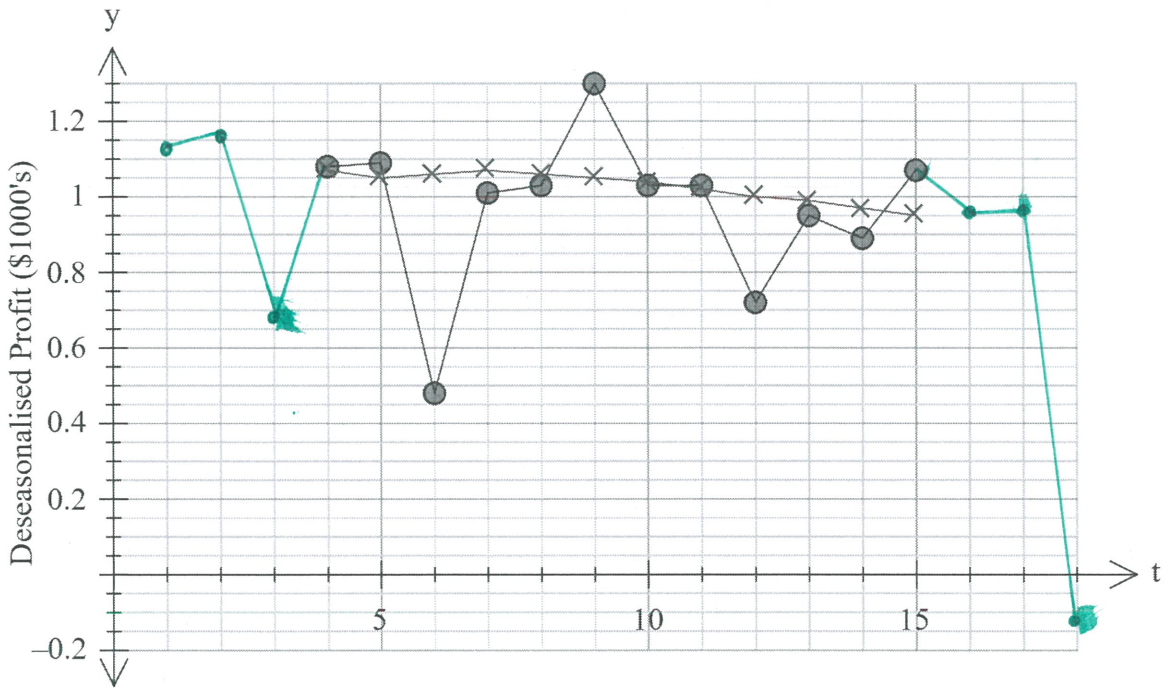
(b) Work backwards to determine the Seasonal Indices of Saturday and Sunday. Show all working to justify your calculations. [4]

SAT $\frac{2.10}{1.09}$ OR $\frac{1.98}{1.03}$ ✓ SUN $\frac{0.04}{0.48}$ OR $\frac{0.06}{0.72}$ ✓

$= 1.9266$ $= 1.9223$ ✓ $= 0.0833$ ✓

(c) Calculate the missing deseasonalised values possible and write them into the original table. [3]

The deseasonalised data from each method is graphed below.



(d) Fill in the missing deseasonalised values calculated in part (c). [2]

✓ 3 correct ✓ All

(e) Comment on the differences in the graphs of deseasonalised data using each method. [2]

The moving average smooths the data more than the seasonal index.

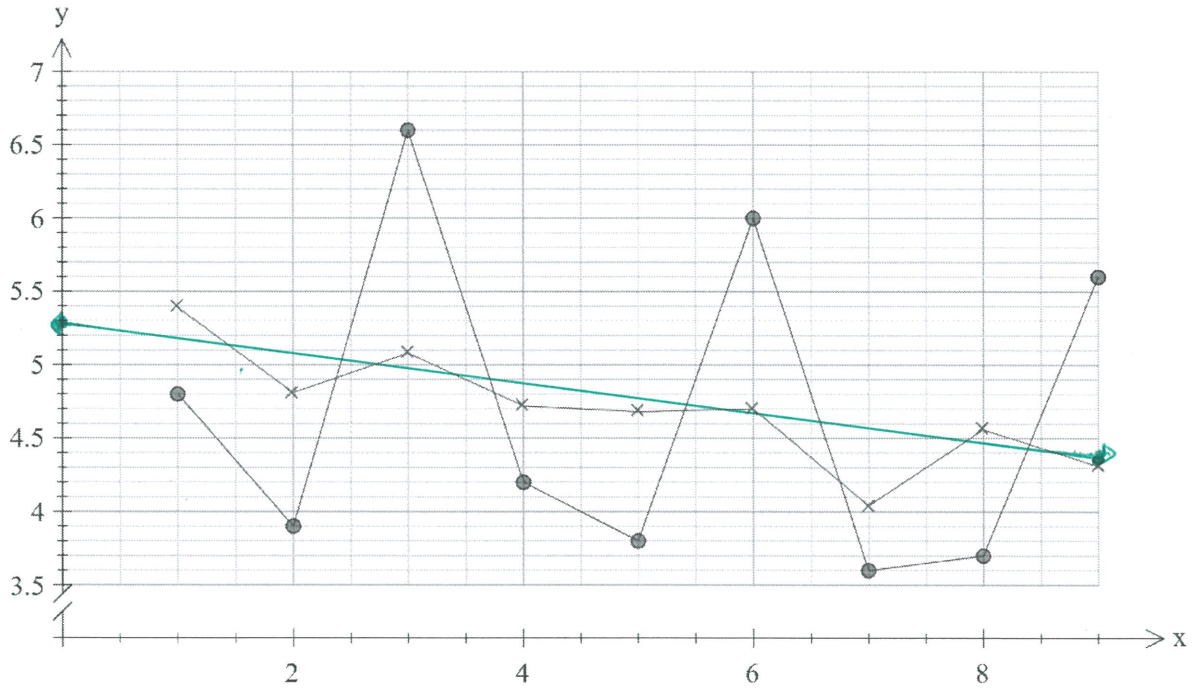
✓✓ or any other valid response

7. (5 marks)

The following table shows the calculation of the 3-point moving average used to smooth time series sales data.

Time Period	Date		Sales	Yearly Mean	Seasonally Adjusted
1	April	2015	4.8		5.39
2	August	2015	3.9	5.10	4.81
3	December	2015	6.6		5.08
4	April	2016	4.2		4.72
5	August	2016	3.8	4.7	4.68
6	December	2016	6.1		4.70
7	April	2017	3.6		4.04
8	August	2017	3.7	4.3	4.56
9	December	2017	5.6		4.31

April	August	December
0.8907	0.8112	1.2981



(a) Calculate the line of least squares regression for the deseasonalised data in the form $d = at + b$. [2]

$d = -0.1195t + 5.2964$ ✓ ✓

(b) Plot the line of least squares regression on the graph above. [2]

y-int ✓ gradient ✓

(c) The prediction from the least squares regression line for August 2018 is 3.98. Comment on the effect of the seasonal index on this prediction. [1]

The seasonal index will decrease the prediction.