TRINITY COLLEGE

# Year 12 Mathematics Applications
# Test 4 2020

Calculator Assumed

**Time Series Data**

**STUDENT'S NAME** _____

**DATE**: Friday 3rd July **TIME:** 50 minutes **MARKS**: 50

**INSTRUCTIONS:**

Standard Items: Pens, pencils, drawing templates, eraser
Special Items: Notes on 1 A4 page (one sided), up to 3 calculators

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

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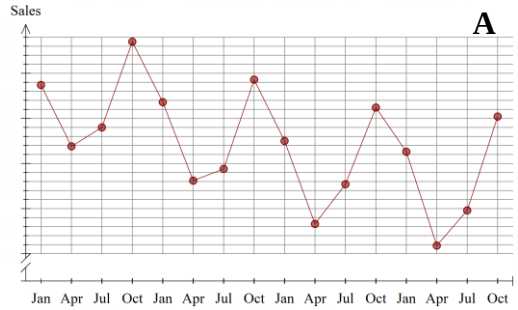
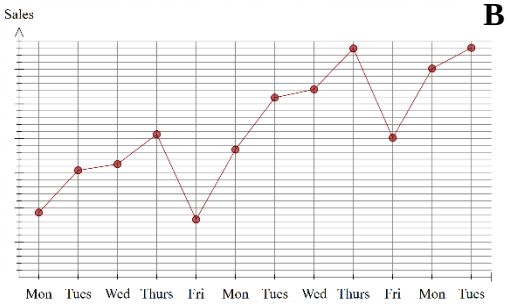
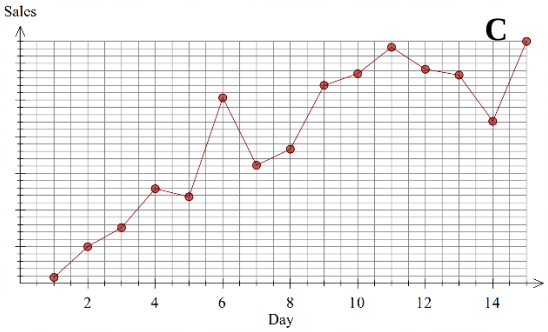
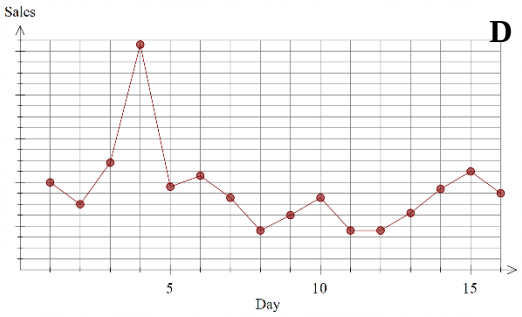
1. (7 marks)

Consider the time series plots below




(a) Describe the features of Graph A [3]

(b) Which graph would it be appropriate to smooth using a 5-point moving mean? [1]

(c) Which graph/s show an increasing trend? [2]

(d) Which graph contains an outlier? [1]

2. (11 marks)

A Zoo recorded the number of visitors it had in quarterly intervals from 2016 to 2019. The data is displayed in the table below

| Year | (*n*) | Time Period | Visitors (in 1000's) | Cycle Mean | Seasonal Effect | Deseasonalised Data (*D*) |
|---|---|---|---|---|---|---|
| 2016 | 1 | Jan - Mar | 78 | 77 | 101.3% | 75.8 |
| | 2 | Apr - Jun | 72 | | 93.5% | 78.5 |
| | 3 | Jul - Sept | 74 | | **C** | 77.4 |
| | 4 | Oct - Dec | 84 | | 109.1% | 76.6 |
| 2017 | 5 | Jan - Mar | 77 | 73 | 105.5% | 74.0 |
| | 6 | Apr - Jun | **A** | | 91.8% | 74.4 |
| | 7 | Jul - Sept | 69 | | 94.5% | 72.5 |
| | 8 | Oct - Dec | 79 | | 108.2% | 72.8 |
| 2018 | 9 | Jan - Mar | 73 | **B** | 104.3% | 69.8 |
| | 10 | Apr - Jun | 63 | | 90.0% | 69.2 |
| | 11 | Jul - Sept | 68 | | 97.1% | 70.8 |
| | 12 | Oct - Dec | 76 | | 108.6% | 69.9 |
| 2019 | 13 | Jan - Mar | 71 | 68 | 104.4% | 68.7 |
| | 14 | Apr - Jun | 61 | | 89.7% | 66.5 |
| | 15 | Jul - Sept | 65 | | 95.6% | **D** |
| | 16 | Oct - Dec | 75 | | 110.3% | 69.0 |

(a) Calculate the values of A, B and C in the table. [3]

(b) Calculate the seasonal index for each Quarter. [2]

| **Quarter** | **1 (Jan – Mar)** | **2 (Apr – Jun)** | **3 (Jul – Sept)** | **4 (Oct – Dec)** |
|---|---|---|---|---|
| **Seasonal Index** | | 91% | 96% | |

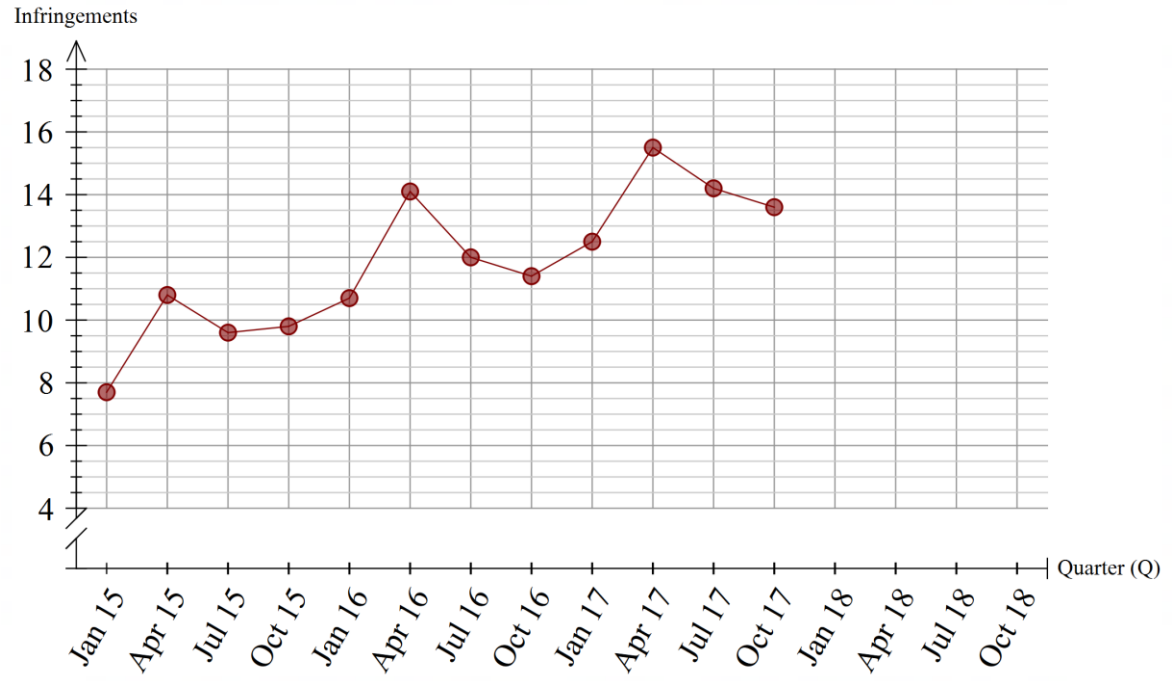
(c) Calculate the value of **D** in the table. [1]

(d) Determine the equation of the least squares' regression line for the Deseasonalised number of visitors to the zoo. [2]

(e) Predict the actual number of visitors to the zoo in the second quarter (Apr – Jun) in 2020. [3]

3. (13 marks)

The graph below shows the quarterly speeding infringements (in 1000's) given out in Western Australia.




The data for the next four quarters is shown in the table below:

| **Quarter** | **January 2018** | **April 2018** | **July 2018** | **October 2018** |
|---|---|---|---|---|
| **Infringements** | 14 000 | 17 500 | 15 250 | 14 500 |

(a) Complete the time series plot by including this additional information. [2]

(b) The equation of the least-squares line for the above data is $I = 466.1029Q + 8735$ where $Q=1$ for January 15 and $Q=2$ for April 15 etc.

(i) Plot this line on the graph above. [2]

(ii) Describe the trend and seasonality of this data. [2]

(c) The 4-point centred moving average for April 2018 is 15 200. Calculate the actual value for October 2017. [2]

(d) The seasonal indices are shown in the table below:

| **Quarter** | **Seasonal Index** |
|---|---|
| January | 87.5% |
| April | 114.1% |
| July | 100.6% |
| October | |

(i) Complete the table above by determining the seasonal index for October. [1]

(ii) Use the seasonal index to determine the Deseasonalised number of infringements for January 2018. [2]

(iii) The Deseasonalised number of infringements for April 2017 is 13 600. Determine the **actual** number of infringements for this quarter. [2]

4. (11 marks)

The table below shows the number of students absent from a school for each quarter for the years 2012 to 2015.

| Year | (*t*) | Time Period | Absentees | Cycle Mean | Seasonal Effect |
|---|---|---|---|---|---|
| 2012 | 1 | Jan - Mar | | | |
| | 2 | Apr - Jun | | | 89.8% |
| | 3 | Jul - Sept | 45 | | |
| | 4 | Oct - Dec | 58 | | |
| 2013 | 5 | Jan - Mar | 39 | 46 | 85.7% |
| | 6 | Apr - Jun | 38 | | 83.5% |
| | 7 | Jul - Sept | 45 | | 98.9% |
| | 8 | Oct - Dec | 60 | | 131.9% |
| 2014 | 9 | Jan - Mar | 38 | 42 | 91.6% |
| | 10 | Apr - Jun | 33 | | 79.5% |
| | 11 | Jul - Sept | 40 | | 96.4% |
| | 12 | Oct - Dec | 55 | | 132.5% |
| 2015 | 13 | Jan - Mar | 29 | 35 | 81.7% |
| | 14 | Apr - Jun | 31 | | 87.3% |
| | 15 | Jul - Sept | 36 | | 101.4% |
| | 16 | Oct - Dec | 46 | | 129.6% |

For the data above, when t = 12, the least-squares regression line for Deseasonalised data against t, gives a predicted value of 39.11 and the predicted actual number of absentees is 50.65

Using this information

(a) Calculate the seasonal index for the quarter that corresponds to $t = 12$. [2]

(b) Calculate the seasonal effect when t = 4. [2]

(c) Calculate the cycle mean for 2012. [2]

(d) Calculate the actual absentees for Jan – Mar of 2012. [3]

(e) Given that the absentees for Jan – March of 2016 is 31. Estimate the total absentees for the year of 2016. [2]

5. (8 marks)

Consider the table of data below.

| Time ($t$) | Sales (in \$000s) | 3pt MA | 4pt CMA | 5pt MA |
|---|---|---|---|---|
| 1 | 8.6 | | | |
| 2 | 28.6 | 20.87 | | |
| 3 | 25.4 | 21.37 | 21.05 | 20.86 |
| 4 | 10.1 | 22.37 | 23.63 | **C** |
| 5 | 31.6 | 22.63 | 21.84 | 21.36 |
| 6 | 26.2 | **A** | 23.43 | 23.22 |
| 7 | 13.5 | 24.80 | 26.16 | 26.98 |
| 8 | 34.7 | 25.70 | 24.70 | 24.10 |
| 9 | 28.9 | 26.93 | 26.59 | 26.38 |
| 10 | 17.2 | 27.90 | 29.49 | 30.44 |
| 11 | 37.6 | 29.53 | 28.83 | 28.40 |
| 12 | **D** | | 31.19 | 30.72 |
| 13 | 24.5 | 32.93 | 34.01 | |
| 14 | 40.5 | 33.97 | 32.94 | 32.32 |
| 15 | 36.9 | 34.43 | 34.04 | 33.80 |
| 16 | 25.9 | 34.67 | **B** | 36.32 |
| 17 | 41.2 | 34.73 | 33.91 | 33.42 |
| 18 | 37.1 | 34.77 | 34.39 | 34.16 |
| 19 | 26.0 | 34.57 | | |
| 20 | 40.6 | | | |

(a) What is the purpose of calculating moving averages for time series data? [1]

(b) Calculate the values of A, B and C. [3]

(c) Which of the moving averages is the most appropriate for smoothing this data and why? [2]

(d) Calculate the value of D. [2]