Rossmoyne Senior High School

Semester Two Examination, 2021

Question/Answer booklet

MATHEMATICS APPLICATIONS UNITS 3&4

Section One: Calculator-free

If required by your examination administrator, please place your student identification label in this box

WA student number: In figures

In words

Circle your Teacher's Name:

| Buckland | Fletcher | Leonard |
| Pisano | Rusk | Tanday |

Time allowed for this section

Reading time before commencing work: five minutes
Working time: fifty minutes

Number of additional answer booklets used (if applicable):

Materials required/recommended for this section

To be provided by the supervisor
This Question/Answer booklet
Formula sheet

To be provided by the candidate
Standard items: pens (blue/black preferred), pencils (including coloured), sharpener, correction fluid/tape, eraser, ruler, highlighters

Special items: nil

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.

Structure of this paper

Section	Number of questions available	Number of questions to be answered	Working time (minutes)	Marks available	Percentage of examination
Section One: Calculator-free	8	8	50	52	35
Section Two: Calculator-assumed	13	13	100	98	65
				Total	100

Instructions to candidates

1. The rules for the conduct of examinations are detailed in the school handbook. Sitting this examination implies that you agree to abide by these rules.

2. Write your answers in this Question/Answer booklet preferably using a blue/black pen.
    Do not use erasable or gel pens.

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

4. 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.

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

6. Supplementary pages for planning/continuing your answers to questions are 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.

7. The Formula sheet is not to be handed in with your Question/Answer booklet.

Markers use only		
Question	Maximum	Mark
1	6	
2	5	
3	7	
4	10	
5	5	
6	6	
7	7	
8	6	
S1 Total	52	
S1 Wt (×0.6731)	35%	
S2 Wt	65%	
Total	100%	

See next page   SN085-186-1

Section One: Calculator-free 35% (52 Marks)

This section has **eight** questions. Answer **all** questions. Write your answers in the spaces provided.

Working time: 50 minutes.

Question 1 (6 marks)

(a) A connected planar graph has 14 vertices and 9 faces. Determine the number of edges this graph has. (2 marks)

(b) The vertices in the following graph can be split into two distinct groups to demonstrate that the graph is bipartite. List the vertices in each group. (2 marks)
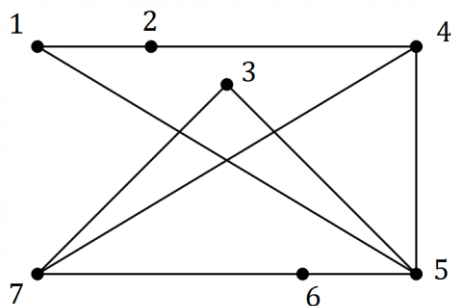
(c) Determine the number of edges that must be removed from a complete graph with 5 vertices so that it becomes a tree with 5 vertices. (2 marks)

Question 2 **(5 marks)**

A sequence is defined as $T_{n+1} = T_n + p$ with $T_1 = q$, so that $T_3 = 28$ and $T_4 = 34$.

(a) Determine the value of the constant p and the value of the constant q. (2 marks)

The sequence can also be written in the form $T_n = pn + k$.

(b) Determine the value of the constant k. (1 mark)

(c) Determine the value of n so that $T_n = 250$. (2 marks)

Question 3 **(7 marks)**

A company runs sightseeing boat trips from several terminals throughout a harbour city. In the graph below, the numbered vertices represent terminals, and the edges represent trips either between the terminals or that start and finish at the same terminal.
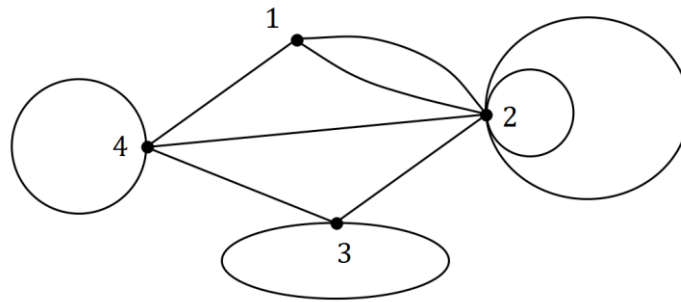
(a)   State two reasons why the graph above is not simple.   (2 marks)

(b)   Construct an adjacency matrix for the above graph.   (2 marks)

(c)   Describe two conditions necessary for the existence of a semi-Eulerian trail in a graph and state the length of such a trail in the above graph.   (3 marks)

See next page

**Question 4**   **(10 marks)**

An analyst collected data from a sample of ten trees in a plantation, as shown in the table below.

The variables x and y are the diameter of a tree in centimetres and the daily water use of the tree in litres respectively.

$\hat{y}$ is the predicted daily water use in litres, calculated using the least-squares line $\hat{y} = 0.9x + 3.3$, and R is the residual.

x	21	25	29	35	41	45	50	54	59	64
y	20.5	25.0	30.0	35.5	41.5	45.0	49.5	52.5	55.0	59.5
$\hat{y}$	22.2	25.8	29.4	34.8	40.2	43.8	-	51.9	56.4	60.9
R	-1.7	-0.8	0.6	0.7	1.3	1.2	-	0.6	-	-1.4

Nine of the data points (x, y) are shown on this scatterplot:
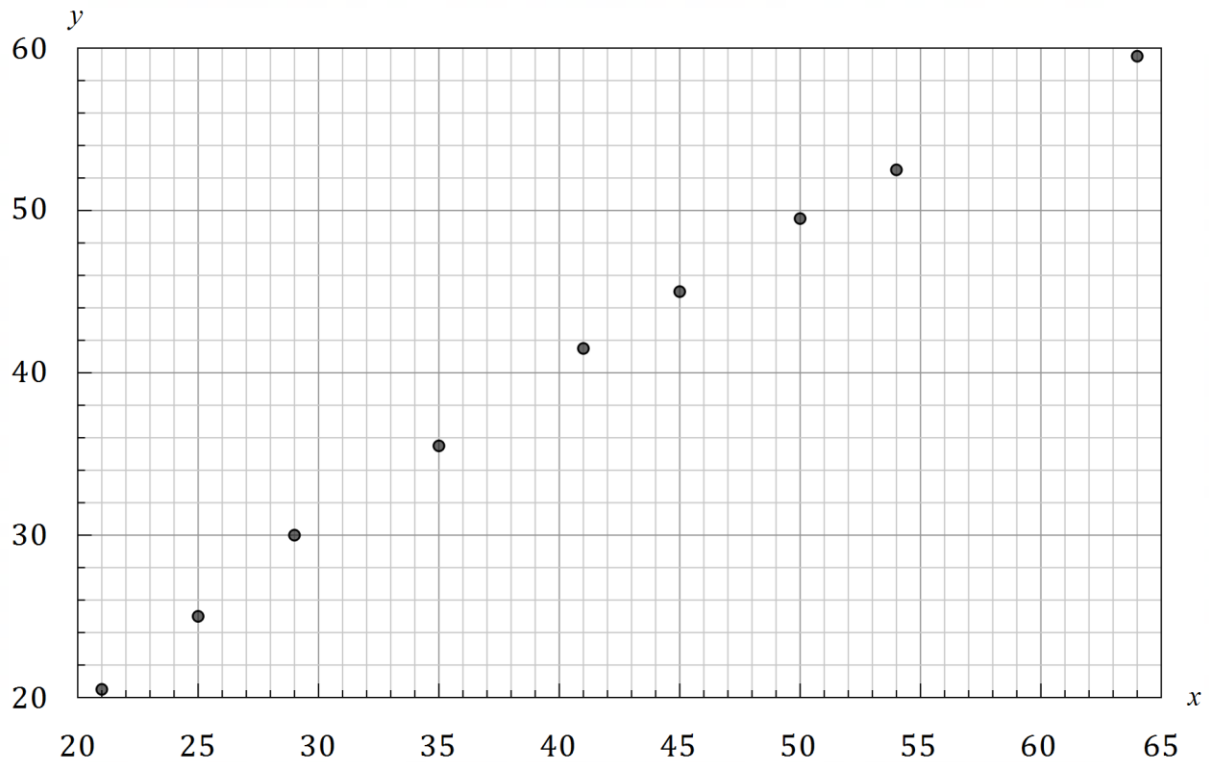
(a)   Add the missing point to the scatterplot.   (1 mark)

(b)   Explain how information from the table can be used to draw the least-squares line on the scatterplot and hence draw this line.   (2 marks)
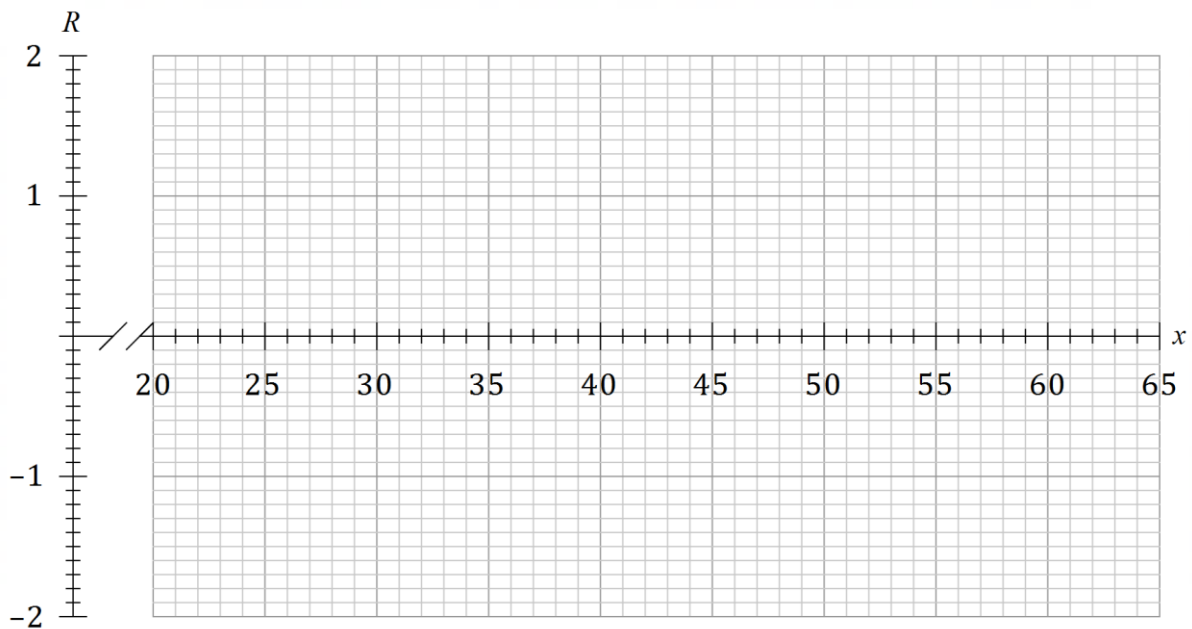
(c) Determine the value of the residual R when:

(i) $x = 59$. (1 mark)

(ii) $x = 50$. (2 marks)

(d) Construct a residual plot on the axes below. (2 marks)

(e) Comment on the appropriateness of fitting a linear model to the data. Justify your answer.
(2 marks)

Question 5 **(5 marks)**

A relay team consists of four cadets who must each be assigned to one of the four sections of an assault course in order to minimise their overall time.

The table shows the least time, in minutes, that each cadet has previously taken to complete the different sections.

	Section			
	1	2	3	4
Dane	27	29	25	28
Ed	27	31	31	33
Finn	29	34	31	35
Guy	26	24	24	29

(a) Show use of the Hungarian algorithm to determine the optimum assignment of cadets, writing the assignment in the table below. (4 marks)

Section	1	2	3	4
Cadet				

(b) State the least overall time for the team to complete the relay. (1 mark)
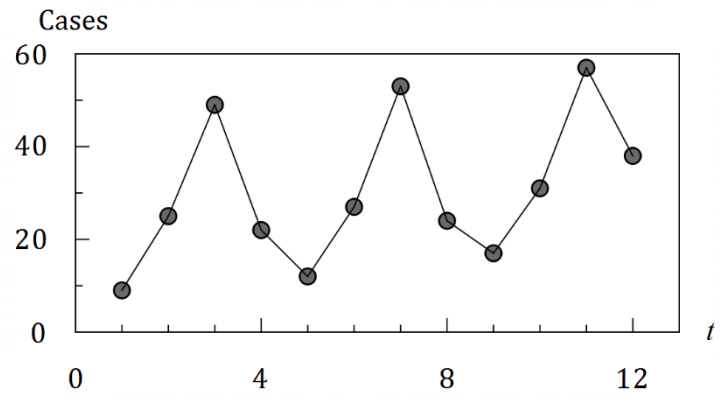
Question 6 **(6 marks)**

A clinic recorded the number of cases of influenza that presented each quarter, and an extract from the data is shown in the table and graph below.

	Cases per quarter			
Year	1	2	3	4
2015	9	25	49	22
2016	12	27	53	24
2017	17	31	57	38

(a) Describe the trend and seasonality of the data. (2 marks)

(b) Calculate the 4-point centred moving average for the number of cases that presented in the second quarter of 2017. (2 marks)

The 3-point moving average for the number of cases that presented in the first quarter of 2015 is 18.
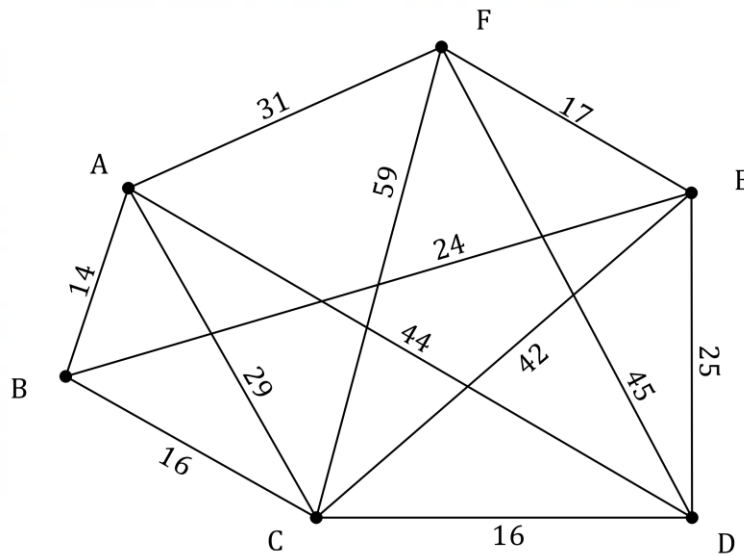
(c) Determine the number of cases that presented in the fourth quarter of 2014. (2 marks)

Question 7 **(7 marks)**

The edge weights on the graph below represent the time, in milliseconds, to send a data packet between routers on a computer network, represented by the vertices.

(a) Determine the minimum time to send a data packet from router C to router F and state, in order, the routers on this path. (3 marks)

(b) Explain, with justification, why the graph in this question is Hamiltonian. (2 marks)

(c) State, with reasoning, the least number of edges that must be removed from the graph so that it is now semi-Hamiltonian. (2 marks)

Question 8   **(6 marks)**

The network below represents the durations and interdependencies of the 11 activities required to complete a project. For example, activity H has a duration of 19 days and cannot commence until activities C and E are complete.
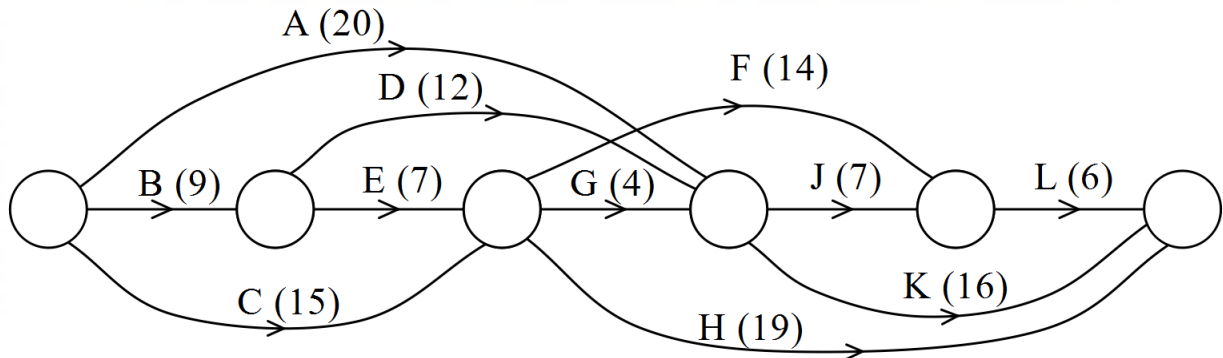
(a)   Determine the minimum completion time for the project.   (2 marks)

(b)   Determine which of the non-critical activities has the greatest float time and state the earliest start time and latest start time for this activity.   (2 marks)

(c)   Proposed changes to the project will decrease the duration of activity D by 4 days. Determine the impact this will have on the critical path of the project and its minimum completion time.   (2 marks)

Supplementary page

Question number: _____

Supplementary page

Question number: _____

Supplementary page

Question number: _____

DO NOT WRITE IN THIS AREA AS IT WILL BE CUT OFF

Supplementary page

Question number: _____