



ATAR course examination, 2017

Question/Answer booklet

MATHEMATICS APPLICATIONS

Section One: Calculator-free

Place one of your candidate identification labels in this box.
Ensure the label is straight and within the lines of this box.

Student number: In figures

--	--	--	--	--	--	--	--	--	--

In words

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	7	7	50	53	35
Section Two: Calculator-assumed	9	9	100	94	65
Total					100

Instructions to candidates

1. The rules for the conduct of the Western Australian external examinations are detailed in the *Year 12 Information Handbook 2017*. Sitting this examination implies that you agree to abide by these rules.
2. Write your answers in this Question/Answer booklet.
3. You must be careful to confine your answer to the specific question asked and to follow any instructions that are specified to a particular question.
4. Supplementary pages for the use of planning/continuing your answer to a question have been 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.
5. 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.
6. It is recommended that you do not use pencil, except in diagrams.
7. The Formula sheet is not to be handed in with your Question/Answer booklet.

See next page

Section One: Calculator-free

35% (53 Marks)

This section has **seven (7)** questions. Answer **all** questions. Write your answers in the spaces provided.

Supplementary pages for the use of planning/continuing your answer to a question have been 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.

Working time: 50 minutes.

Question 1

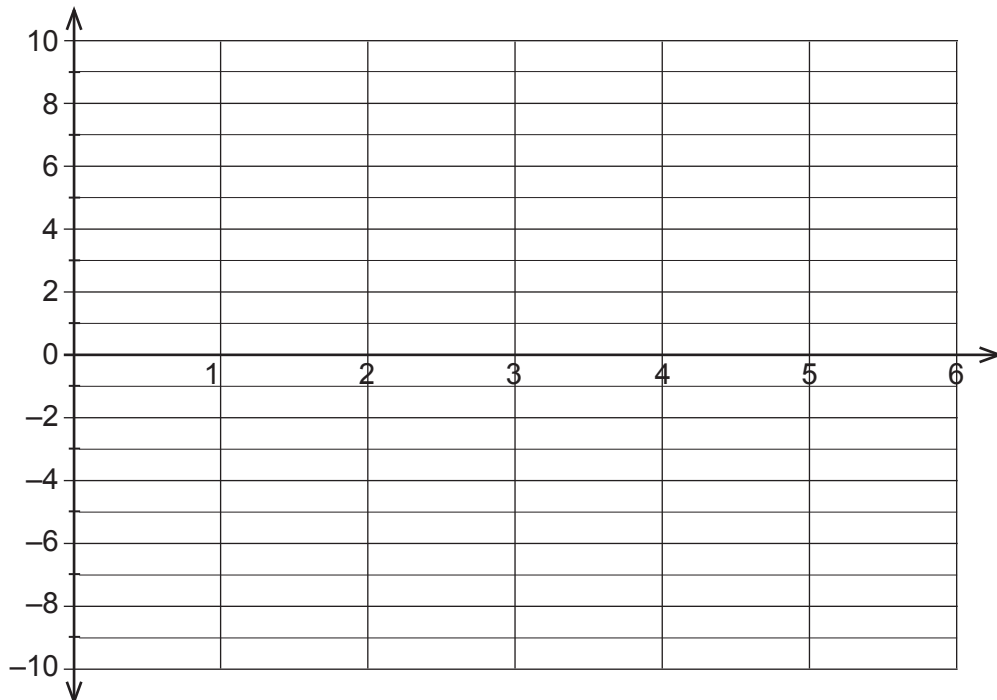
(8 marks)

Consider the following recurrence relation:

$$T_{n+1} = T_n - 3, \quad T_3 = 2.$$

- (a) Display the first six terms of this sequence on the axes below. Label the axes clearly.

(3 marks)



- (b) (i) Deduce a rule for the n^{th} term of this sequence.

(2 marks)

- (ii) Hence, determine the first term in the sequence which is less than -500 .

(3 marks)

Question 2

(7 marks)

A supermarket provides a delivery service to its customers. This morning, there are four deliveries (1, 2, 3 and 4) to be made. Each of four drivers, John, Kerry, Liam and Max, is available to do one of the deliveries.

The table below shows the time, in minutes, that each driver would take to complete each of the four deliveries.

Table 1

Delivery Driver

		John	Kerry	Liam	Max
Deliveries	1	35	31	41	36
	2	25	26	33	36
	3	32	28	25	24
	4	27	30	31	28

The store manager will allocate the deliveries so that the total delivery time is at a minimum. He decides to use the Hungarian algorithm to determine the allocation of deliveries to the drivers.

His first step is to subtract the minimum entry in each row from each element, ensuring that each row contains at least one zero.

Table 2

Delivery Driver

		John	Kerry	Liam	Max
Deliveries	1	4	0	10	5
	2	0	1		11
	3	8	4	1	0
	4	0	3	4	1

- (a) What is the number missing from the shaded cell? (1 mark)

The second step is to ensure that all columns contain at least one zero. The numbers that result from this step are shown in the table below.

Table 3

Delivery Driver

		John	Kerry	Liam	Max
Deliveries	1	4	0	9	5
	2	0	1	7	11
	3	8	4	0	0
	4	0	3	3	1

See next page

- (b) The smallest number of horizontal and vertical lines that can be drawn to cover all the zeros is three.
- (i) Draw in these lines on **Table 3** on the previous page. (1 mark)
- (ii) State why an allocation of delivery drivers cannot be made yet. (1 mark)
- (c) Continue the steps of the Hungarian algorithm to determine the optimum allocation of deliveries to the drivers. Complete the table at the bottom of the page and state the minimum total delivery time. (4 marks)

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

Delivery Driver	John	Kerry	Liam	Max
Delivery				

Minimum total delivery time _____

See next page

Question 3

(11 marks)

- (a) A planar graph has five faces and five vertices, A, B, C, D and E.
- (i) Determine the number of edges for this graph. (2 marks)
- (ii) Draw the planar graph in the space below. (2 marks)
- (iii) Determine a Hamiltonian cycle for the graph, giving your answer as a sequence of vertices. (1 mark)
- (iv) Is the graph Eulerian, semi-Eulerian or neither? Justify your answer. (2 marks)
- (b) (i) A simple connected graph contains five vertices. Determine the minimum and the maximum number of edges it contains. (2 marks)
- (ii) A simple connected graph contains n vertices. Determine the minimum number of edges it contains. (1 mark)
- (iii) What name is given to the simple connected graph with the maximum number of edges possible? (1 mark)

See next page

Question 4

(5 marks)

Ryan was keen to compare interest rates offered by different banks, so he decided to construct a table showing the effective annual rates of interest (%). Part of his table is shown below.

Compounding period	Rate of interest (p.a.)				
	4%	4.5%	5%	5.5%	6%
Quarterly	4.060	4.577	5.095	5.614	6.136
Monthly	4.074	4.594	5.116	5.641	6.168
Daily	4.081	4.602	5.127	5.654	6.183

- (a) Ryan wants to borrow \$5000 to purchase a second-hand car. A bank offers to lend him the money at the rate of 6% p.a. for one year. He plans to pay off the entire loan (including the interest) at the end of the year. Which compounding period should he sign up for? Justify your decision. (2 marks)
- (b) Ryan is curious to know how much interest he would earn by investing \$100 for a year, earning 4% p.a. with interest compounded quarterly. Determine the interest he would earn. (1 mark)
- (c) Ryan's sister has \$3000 to invest for a year. She has been offered a rate of 5% p.a., with interest compounded daily. Determine the value of her investment at the end of the year. (2 marks)

Question 5

(9 marks)

A group of university students was asked the question ‘Does full attendance at school lead to an improved examination result?’

The results are summarised below.

	Agree	Disagree	Undecided
Male under 20 years	8	22	6
Female under 20 years	6	20	8
Male 20 to 25 years	26	7	3
Female 20 to 25 years	30	9	5
Male over 25 years	24	3	2
Female over 25 years	18	2	1

(a) Complete the two-way table below.

(2 marks)

	Agree	Disagree	Undecided
Under 20	14		
20–25			
Over 25			3

(b) State the explanatory variable for these data.

(1 mark)

- (c) The incomplete table below shows row percentages.

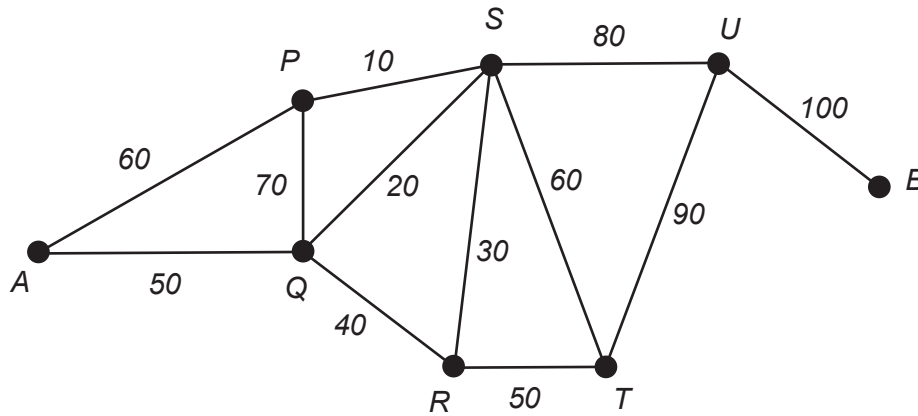
	Percentages		
	Agree	Disagree	Undecided
Under 20		60	
20–25		20	
Over 25	84		

- (i) Show how the value of 20% was calculated. (2 marks)
- (ii) Complete the table. (2 marks)
- (d) Use the data to determine one association between the variables. Describe the association and explain your reasoning. (2 marks)

Question 6

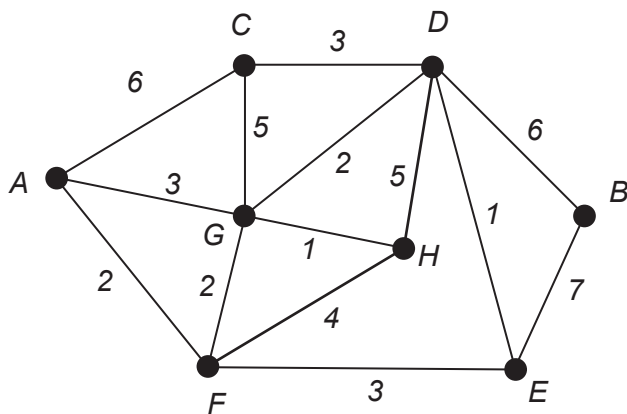
(7 marks)

- (a) In the network below, the nodes represent towns and the numbers on the arcs represent the time taken (in minutes) to travel between them.

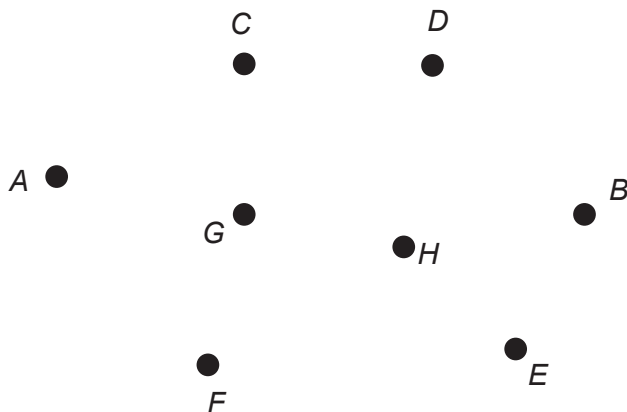


A driver leaves Town A and must deliver goods to all the other towns in the shortest time, finishing at Town B. Determine this shortest time. (A town may be visited more than once). (3 marks)

- (b) The network below shows the distances (in metres) between stations for a model railway track system.



- (i) Determine the minimal spanning tree for the network and draw this tree on the diagram below. (3 marks)



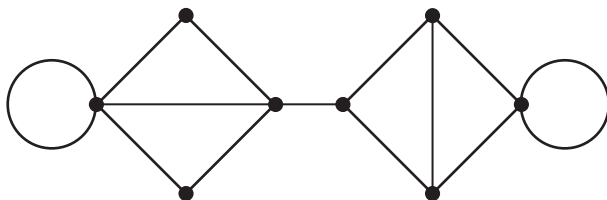
- (ii) State the length of the minimal spanning tree. (1 mark)

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

Question 7

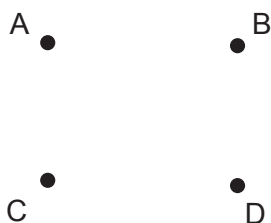
(6 marks)

(a) The graph below shows the paths connecting the exhibits at a zoo.



- (i) Explain why the graph is not semi-Eulerian. (1 mark)
 - (ii) Draw one edge on the graph so that it becomes semi-Eulerian and does not contain a bridge. (2 marks)
- (b) The adjacency matrix Q represents the raised paths connecting the observation platforms in the safari section at the zoo. Draw a planar graph for the adjacency matrix. (3 marks)

$$Q = \begin{matrix} & \begin{matrix} A & B & C & D \end{matrix} \\ \begin{matrix} A \\ B \\ C \\ D \end{matrix} & \begin{bmatrix} 0 & 2 & 1 & 1 \\ 2 & 0 & 1 & 1 \\ 1 & 1 & 0 & 0 \\ 1 & 1 & 0 & 1 \end{bmatrix} \end{matrix}$$



Supplementary page

Question number: _____

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

Supplementary page

Question number: _____

Supplementary page

Question number: _____

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

This document – apart from any third party copyright material contained in it – may be freely copied, or communicated on an intranet, for non-commercial purposes in educational institutions, provided that it is not changed and that the School Curriculum and Standards Authority is acknowledged as the copyright owner, and that the Authority's moral rights are not infringed.

Copying or communication for any other purpose can be done only within the terms of the *Copyright Act 1968* or with prior written permission of the School Curriculum and Standards Authority. Copying or communication of any third party copyright material can be done only within the terms of the *Copyright Act 1968* or with permission of the copyright owners.

Any content in this document that has been derived from the Australian Curriculum may be used under the terms of the Creative Commons [Attribution 4.0 International \(CC BY\)](https://creativecommons.org/licenses/by/4.0/) licence.

*Published by the School Curriculum and Standards Authority of Western Australia
303 Sevenoaks Street
CANNINGTON WA 6107*