

The Mathematical Association of Victoria

Trial Examination 2019

FURTHER MATHEMATICS

Written Examination 2

STUDENT NAME: _____

Reading time: 15 minutes
Writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of Book

Section A - Core	<i>Number of questions</i>	<i>Number of questions to be answered</i>	<i>Number of marks</i>
	8	8	36
Section B - Modules	<i>Number of modules</i>	<i>Number of modules to be answered</i>	<i>Number of marks</i>
	4	2	24
			Total 60

- Students are to write in blue or black pen.
- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, one bound reference, one approved technology (calculator or software) and, if desired, one scientific calculator. Calculator memory DOES NOT need to be cleared. For approved computer-based CAS, full functionality may be used.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied

- Question and answer book of 37 pages
- Formula sheet.
- Working space is provided throughout the book.

Instructions

- Write your **name** in the space provided above on this page.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.
- All written responses must be in English.

Students are NOT permitted to bring mobile phones and/or any other unauthorised electronic devices into the examination room.

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Section A – CORE**Instructions for Section A**

Answer **all** questions in the spaces provided.

You need not give numerical answers as decimals unless instructed to do so. Alternative forms may include, for example, π , surds or fractions.

In ‘Recursion and financial modelling’, all answers should be rounded to the nearest cent unless otherwise instructed.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale

Data Analysis**Question 1** (4 marks)

At a local supermarket, 20 customers were surveyed after they had completed their shopping during one particular hour.

The customers were asked about six variables:

- *gender* (male = 1, female = 2, not specified = 3)
- *age* (in years)
- *satisfaction* with their shopping experience (satisfied = 1, not satisfied = 2)
- *distance* travelled to supermarket (correct to nearest km)
- *amount spent* (correct to nearest dollar)
- *wait time* at the register (correct to nearest minute)

The results are shown in Table 1 below:

Table 1

Customer Number	<i>gender</i>	<i>age</i>	<i>satisfaction</i>	<i>distance travelled</i>	<i>amount spent</i>	<i>wait time</i>
1	1	23	1	4	\$24	3
2	1	45	2	1	\$43	12
3	2	34	1	2	\$21	3
4	2	18	1	4	\$120	2
5	2	21	1	0	\$32	5
6	2	56	1	1	\$23	6
7	1	78	1	2	\$54	2
8	2	19	2	5	\$2	8
9	2	65	1	8	\$67	2
10	1	24	1	12	\$154	11
11	2	61	2	17	\$203	1
12	2	43	1	2	\$13	2
13	3	39	1	1	\$34	1
14	2	38	1	3	\$87	7
15	2	77	1	5	\$91	3
16	1	64	2	4	\$87	4
17	1	32	1	3	\$32	1
18	1	47	1	9	\$12	5
19	2	55	1	2	\$41	1
20	2	51	1	8	\$56	0

SECTION A – Question 1- continued

TURN OVER

- a. How many of the variables in this data set are numerical variables? 1 mark

- b. Of the customers who identified themselves as female, what percentage were **not** satisfied with their shopping experience?

Give your answer as a percentage correct to one decimal place. 1 mark

The supermarket management is interested in the *wait times* of their customers. They classify the *wait times* as follows:

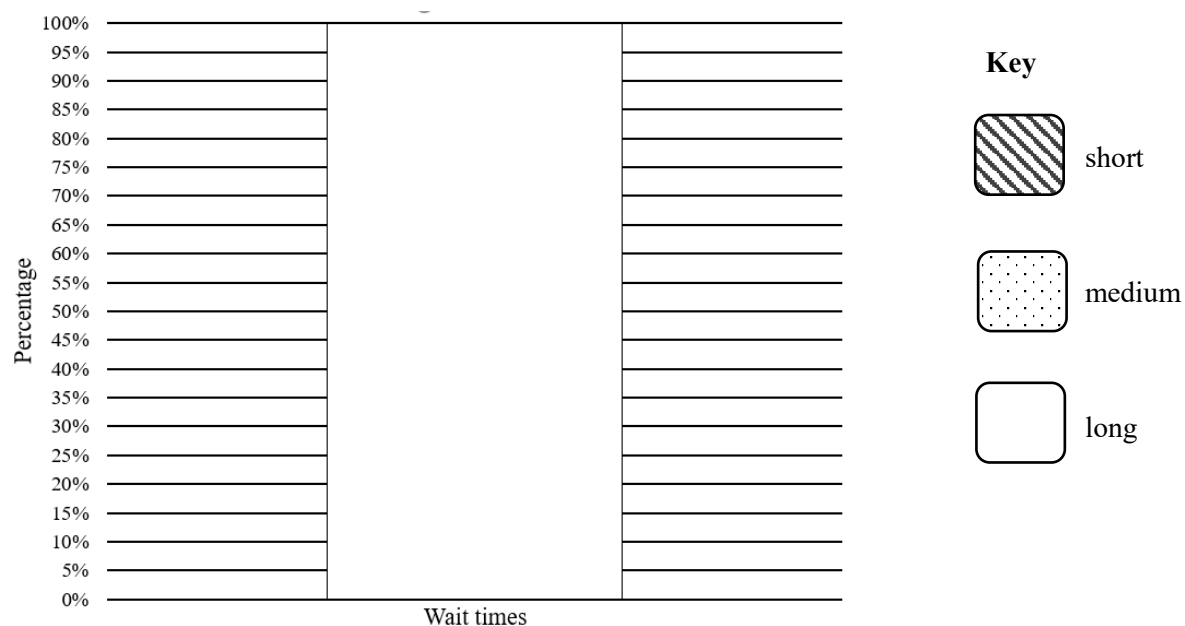
- a short *wait time* is five minutes or less
 - a medium *wait time* is more than five minutes to ten minutes or less
 - a long *wait time* is more than ten minutes.
- c. Complete Table 2 below of the percentages of customers in this survey whose *wait times* were short, medium or long using the supermarket's classification. 1 mark

Table 2

<i>wait time</i>	Percentage
short	
medium	
long	

SECTION A - Question 1 - continued

- d.** Use the percentages in Table 2 to construct a percentaged segmented bar chart. A template is provided to assist you. Use the provided key to indicate the segment that corresponds to each category of *wait time*. 1 mark



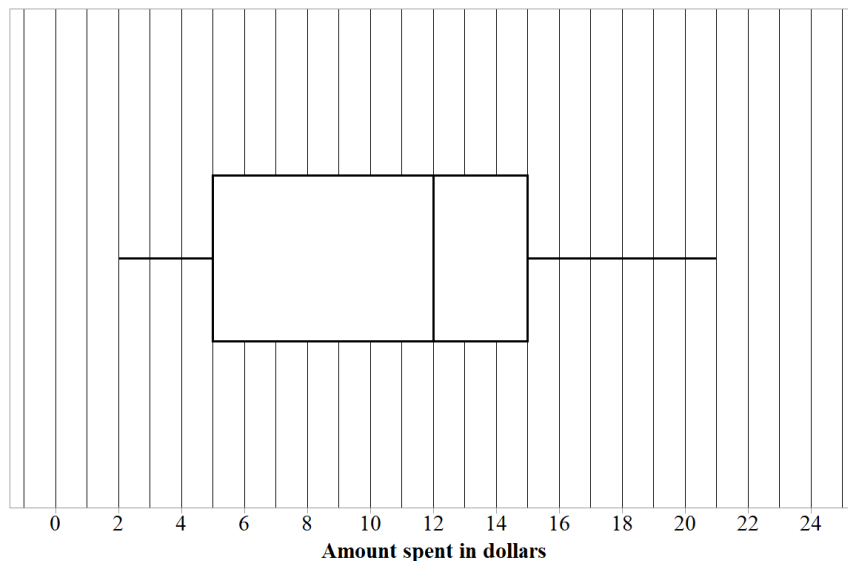
SECTION A – continued

TURN OVER

Question 2 (4 marks)

At a supermarket, the total price in dollars, correct to the nearest dollar, spent by 168 customers at the self-serve register over a one hour period was recorded.

A boxplot of the amounts spent is shown below:



- a. What percentage of customers spent less than \$12 at the self-serve register during this hour?

1 mark

- b. How many customers spent more than \$15 at the self-serve register during this hour?

1 mark

- c. The largest amount spent at the self-serve register during this hour was \$21.

Explain why the sale of \$21 was not an outlier in this data set.

Include an appropriate calculation to support your answer.

2 marks

SECTION A – continued

Question 3 (3 marks)

In a larger survey it was found that the *amount spent* by all customers is normally distributed with a mean sales amount of \$93.60 and a standard deviation of sales amounts of \$21.20.

- a.** What percentage of sales at this supermarket would be expected to be above \$136.00?

1 mark

Customers who spend more than \$30.00 at the supermarket get a fuel discount voucher.

- b.** On one day a total of 12 000 customers went to the supermarket.

How many of these customers did not get a fuel discount voucher?

1 mark

Amira buys four packets of washing powder. The total price that she pays would have a standardised score of -1.6 .

- c.** How much was each packet of washing powder?

1 mark

SECTION A – continued**TURN OVER**

Question 4 (3 marks)

Customers at the supermarket were surveyed about the contents of their trolleys. Each customer was asked their *age group* (under 25 years, 25 to less than 45 years, 45 years or more) and the *items purchased* (food, drinks, other) that they spent most on in their trolley.

- a. Both of the variables *age group* and *items purchased* are categorical variables.

Which variable is also nominal?

1 mark

The percentages of customers who spent most on food, drinks and other in each of the age groups are shown in Table 3 below:

Table 3

		<i>age group</i>		
		Under 25	25 to less than 45	45 or more
<i>items purchased</i>	Food	64%	25%	43%
	Drinks	21%	10%	15%
	Other	15%	65%	42%
	Total	100%	100%	100%

- b. Based on the information in Table 3, are the *items purchased* that customers spent most on associated with the *age group* of the customers at this supermarket?
Explain your answer with reference to appropriate statistics from this table.

2 marks

SECTION A – continued

Question 5 (3 marks)

In a different larger survey, there is an association between the *amount spent* at the supermarket in total and the *age* of the customers. The value of the correlation coefficient for this relationship is 0.61.

The following information was obtained over an extended period of time:

	Mean	Standard deviation
<i>Age</i>	37.2	6.7
<i>amount spent</i>	\$93.60	\$21.20
$r = 0.61$		

- a. **Show** that the least squares regression equation, correct to two decimal places, for the association between the *amount spent* and *age* is:

$$\text{amount spent} = 21.80 + 1.93 \times \text{age}$$

2 marks

- b. Interpret the meaning of the slope of the least squares regression line in this context.

1 mark

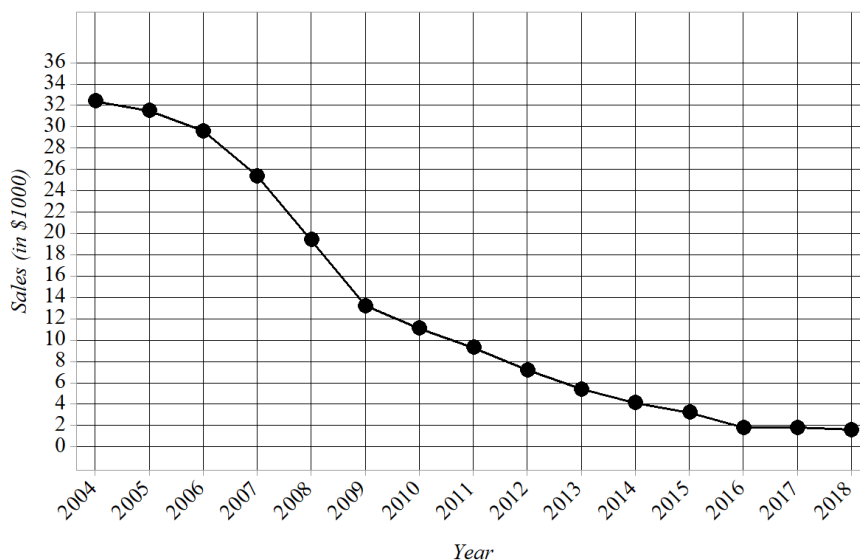
SECTION A – continued**TURN OVER**

Question 6 (4 marks)

The supermarket sells many items including greeting cards. Over a number of years the manager has noticed a significant decrease in the number of greeting cards being sold.

The *sales (in \$1000)* of greeting cards over the last 15 years is shown in Table 4. A time series plot of this data is also shown below:

Year	sales (in \$1000)
2004	32.4
2005	31.5
2006	29.6
2007	25.4
2008	19.4
2009	13.2
2010	11.1
2011	9.3
2012	7.2
2013	5.4
2014	4.1
2015	3.2
2016	1.8
2017	1.8
2018	1.6



The association between the *sales (in \$1000)* and the *year* for greeting card sales is non-linear.

A $\log_{10}$ transformation of the *sales (in \$1000)* axis can be used to linearise the data.

- a. Apply this transformation to the data to determine the equation of the least squares line that can be used to predict $\log_{10}(\text{sales(in \$1000)})$ from the *year*.

Write the values of the intercept and slope of this least squares line, correctly rounded to four significant figures. 2 marks

- b. Calculate the residual of *sales (in \$1000)* for the *year* 2008, using the transformed equation that you have determined. Give your answer correct to one decimal place. 2 marks

SECTION A – continued

Question 7 (3 marks)

The supermarket sells sunscreen but they find that the sales vary during the year on a seasonal basis. Over time they have determined that the seasonal indices for sunscreen sales are as follows:

Season	Summer	Autumn	Winter	Spring
Seasonal index	1.85	0.79		1.12

The seasonal index for Winter is missing.

- a.** Determine the seasonal index for Winter based on this information. 1 mark

The *deseasonalised sales* in \$1000 for sunscreen from the supermarket at any *time* can be determined from the least squares regression equation:

$$\text{Deseasonalised sales} = 3.4 + 0.3 \times \text{time}$$

where *time* = 1 is Summer 2017, *time* = 2 is Autumn 2017, etc.

- b.** Predict the actual sales of sunscreen in Spring 2019 based on this equation.
Give your answer correct to the nearest one hundred dollars. 2 marks

SECTION A – continued

TURN OVER

Recursion and financial modelling**Question 8** (5 marks)

Oliver is a keen cyclist who hopes to become a professional cyclist.
He purchased a quality road bike for training and competitions.

The road bike was purchased for \$6640 and could be depreciated using the reducing balance depreciation method with the recurrence relation

$$V_0 = 6640, \quad V_{n+1} = 0.852V_n$$

where V_n is the value, in dollars, of the road bike after n years.

- a.** Using the recurrence relation, show that the value of the road bike after two years is \$4820, correct to the nearest dollar. 1 mark

- b.** State the annual reducing balance depreciation rate for Oliver's road bike. 1 mark

Oliver plans to sell the road bike when its value drops below \$1300.

- c.** When would he sell the road bike if he follows this plan? 1 mark

SECTION A – Question 8 - continued

Ideally, Oliver would sell the road bike after 6 years. He could opt to depreciate the road bike using the flat rate depreciation method with the recurrence relation

$$F_0 = 6640, \quad F_{n+1} = F_n - k$$

where F_n is the value, in dollars, of the road bike after n years.

- d. i.** What is the minimum value of k that gives a book value of \$1300 after six years? 1 mark

- ii.** Hence, what is the annual flat rate depreciation rate, correct to one decimal place? 1 mark

SECTION A – continued

TURN OVER

Question 9 (7 marks)

Oliver has a sponsor who has set up an annuity to provide for the costs of competing in road races.

- The sponsor has invested \$120 000.
- The investment earns 6.2% per annum interest compounding quarterly.
- Oliver receives a payment of \$6000 each quarter after the interest has been added.

The amortisation table shows the payment received, interest, principal reduction and the balance of the annuity after the first payment.

Payment Number	Payment	Interest	Principal Reduction	Balance of Annuity
0	0.00	0.00	0.00	120 000.00
1	6000.00	1860.00	4140.00	115860.00
2	6000.00	1795.83	A	111655.83
3	6000.00	B	4269.33	C

- a. Find the values of A, B and C in the table. 2 marks

- b. Complete the recurrence relation that would give the balance A_n of the annuity, after n quarters. 1 mark

$$A_0 = 120\,000, \quad A_{n+1} = \underline{\hspace{2cm}} \times A_n - 6000$$

- c. i. If Oliver continues to take a payment of \$6000 every quarter from the annuity how long would the annuity continue to make payments? 1 mark

- ii. What would the value of the last payment be? 1 mark

SECTION A – Question 9 - continued

After one year the sponsor decides that the annuity should become a perpetuity with an interest rate of 7.8% per annum, compounding quarterly.

- d.** What is the payment that Oliver can take, each quarter, from the perpetuity? 2 marks

END OF SECTION A

TURN OVER

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SECTION B – Modules**Instructions for Section B**

Select **two** modules and answer **all** questions within the selected modules.

You need not give numerical answers as decimals unless instructed to do so. Alternative forms may include, for example, π , surds or fractions.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale

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SECTION B – continued
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Module 1: Matrices**Question 1** (3 marks)

Hendricke runs a shop selling mobile phones. He sells both locked (L) and unlocked (U) phones and he sells standard Phones (P) and Android (A) phones.

The number of each type of phone Hendricke sold in February 2018 is shown in the matrix, N , below.

$$N = \begin{matrix} & \begin{matrix} P & A \end{matrix} \\ \begin{bmatrix} 80 & 50 \\ 10 & 20 \end{bmatrix} & \begin{matrix} L \\ U \end{matrix} \end{matrix}$$

- a. How many locked phones did Hendricke sell in total in February 2018? 1 mark

Hendricke calculates the matrix multiplication $Q = \begin{bmatrix} 1 & 1 \end{bmatrix} \times N$.

- b. What do the elements of matrix Q represent in the context of this problem? 1 mark

After February, 2018, Hendricke will only sell one model of unlocked standard Phone (P) and one model of unlocked Android (A) phone.

In March, 2018, he sells 20 standard Phones and 14 Android phones with a total revenue of \$33 800.

In April, 2018, he sells 43 standard Phones and 30 Android phones with a total revenue of \$72 600.

Let x be the cost of the standard Phone (P) and y be the cost of the Android (A) phone.

His accountant uses this information, and the matrix calculation below, to determine the price of each of the phones:

$$\begin{bmatrix} x \\ y \end{bmatrix} = R \times \begin{bmatrix} 33800 \\ 72600 \end{bmatrix}$$

- c. Write down matrix R that would be used in this equation. 1 mark

SECTION B – Module 1 – continued

Question 2 (2 marks)

Hendricke also repairs mobile phones at his shop. He always checks the screen (S), the battery (B), the power button (J), for water damage (W), the camera (C) and the microphone (M).

He follows a set routine when completing repairs that always starts with the screen (S).

His routine is directed by the matrix, E , shown below:

$$E = \begin{matrix} & \begin{matrix} S & B & J & W & C & M \end{matrix} \\ \begin{bmatrix} 0 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 & 0 & 0 \end{bmatrix} & \begin{matrix} S \\ B \\ J \\ W \\ C \\ M \end{matrix} \end{matrix}$$

- a. Hendricke will start with the screen.

Write down, in order, the checks that Hendricke does when he follows his set routine.

1 mark

Hendricke has been charging the following costs for repairs:

- a base fee (F) of \$50
- an hourly fee (H) of \$30 for every hour he works on the phone
- \$80 for a new screen (S)
- \$50 for a new battery (B)

Hendricke will increase his base fee by 15%, increase his hourly charge by 10%, decrease the new screen cost by 10% and decrease the new battery charge by 5%.

To upgrade his prices he will complete the matrix multiplication

$$V \times \begin{bmatrix} 50 \\ 30 \\ 80 \\ 50 \end{bmatrix} \begin{matrix} F \\ H \\ S \\ B \end{matrix} \quad \text{where } V \text{ is a } 4 \times 4 \text{ diagonal matrix.}$$

- b. Write down matrix V .

1 mark

SECTION B – Module 1 – continued

TURN OVER

Question 3 (7 marks)

Hendricke has a number of regular customers who have phones on a month by month plan.

The customers pay for their plan at the end of each month and they are free to change plans each month.

Each month the customers can move to the top plan (T), have their phone at the standard plan (K), move their phone to the low plan (D) or cancel their phone and leave permanently (X).

At the end of each month, the number of Hendricke's customers paying for each plan is given by G_n where n is the number of months after the end of 2018. Therefore G_1 shows the number of customers paying for each plan at the end of January and G_2 shows the number of customers paying for each plan at the end of February, and so on. G_2 is shown below:

$$G_2 = \begin{bmatrix} 100 \\ 700 \\ 200 \\ 0 \end{bmatrix} \begin{matrix} T \\ K \\ D \\ X \end{matrix}$$

Over many months, Hendricke has determined that his customers change their plans according the matrix, Z , below:

$$Z = \begin{matrix} & \begin{matrix} \text{this month} \\ T & K & D & X \end{matrix} \\ \begin{bmatrix} 0.5 & 0.1 & 0 & 0 \\ 0.2 & 0.7 & 0.1 & 0 \\ 0.2 & 0.2 & 0.8 & 0 \\ 0.1 & 0 & 0.1 & 1 \end{bmatrix} & \begin{matrix} T \\ K \\ D \\ X \end{matrix} \end{matrix} \begin{matrix} \\ \\ \\ \text{next month} \end{matrix}$$

The number of customers on each plan each month can be determined using the matrix equation:

$$G_{n+1} = Z \times G_n$$

- a.** How many customers will be paying for the top plan at the end of April? 1 mark

- b.** How many customers would have been paying for the standard plan at the end of January? 1 mark

SECTION B – Module 1 — Question 3 - continued

- c. What percentage of the customers on the low plan at the end of April would have been on the standard plan at the end of March?

Give your answer as a percentage correct to one decimal place.

2 marks

- d. At the end of which month would Hendricke have first lost more than 40% of his customers under this arrangement?

1 mark

SECTION B – Module 1 – continued

TURN OVER

Hendricke is concerned that he is losing too many of his customers and so he starts a campaign to encourage the customers on the low plan to stay. His campaign changes the matrix Z to matrix Z_1 as shown below:

$$Z_1 = \begin{array}{ccccc} & \begin{array}{cccc} \text{this month} \\ T & K & D & X \end{array} & \\ \begin{array}{c} T \\ K \\ D \\ X \end{array} & \begin{bmatrix} 0.5 & 0.1 & 0 & 0 \\ 0.2 & 0.7 & x & 0 \\ 0.2 & 0.2 & y & 0 \\ 0.1 & 0 & 0 & 1 \end{bmatrix} & \begin{array}{c} T \\ K \\ D \\ X \end{array} & \begin{array}{c} \text{next month} \end{array} \end{array}$$

The matrix at the end of February $G_2 = \begin{bmatrix} 100 \\ 700 \\ 200 \\ 0 \end{bmatrix} \begin{array}{c} T \\ K \\ D \\ X \end{array}$

and the matrix at the end of March is now $G_3 = \begin{bmatrix} 120 \\ 590 \\ 280 \\ 10 \end{bmatrix} \begin{array}{c} T \\ K \\ D \\ X \end{array}$ where $G_{n+1} = Z_1 \times G_n$.

- e. State the values of x and y in the matrix Z_1 . (2 marks)

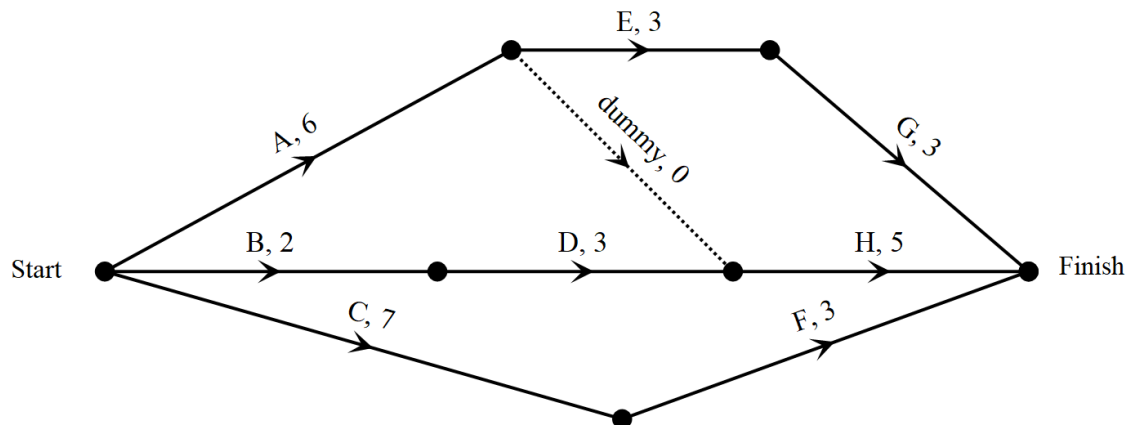
END OF MODULE 1 – SECTION B – continued

Module 2: Network and Decision Mathematics**Question 1** (4 marks)

Khosi is a new airline, based in Johannesburg (JHB).

Setting up the new airline project involves 8 major activities, A to H.

The directed network below shows these activities and their completion times, in weeks.



- a. Determine the earliest starting time for activity H. 1 mark

- b. Write down the critical path for this activity network. 1 mark

- c. Explain why this network requires a *dummy* activity. 1 mark

- d. How many activities have a float time of 2 weeks? 1 mark

SECTION B – Module 2 – continued

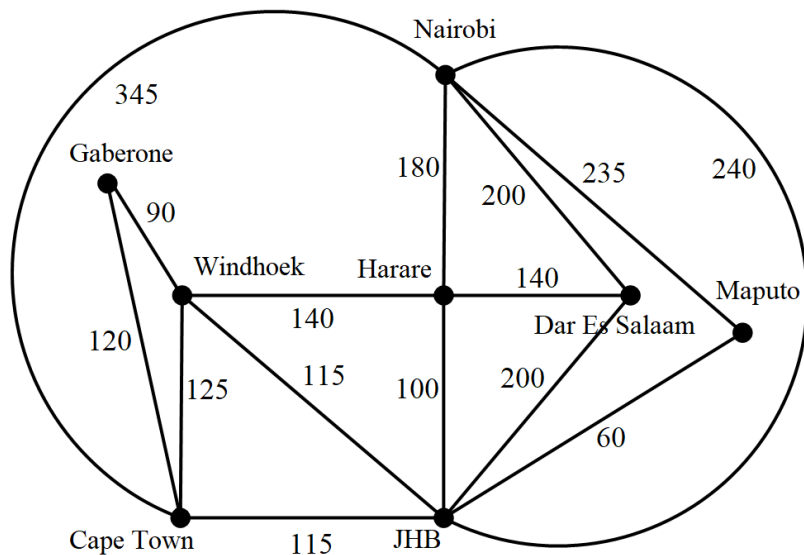
TURN OVER

Question 2 (3 marks)

Khosi want to open routes to eight prominent cities in Southern and Eastern Africa.

The network below gives the *fastest flight time*, in minutes, where there are direct flights between the cities.

For example, there is a direct flight between Harare and Dar Es Salaam and the *fastest flight time* is 140 minutes.



- a. Explain in the context, the information given by the degree of a vertex, in this network.

1 mark

- b. In the adjacency matrix shown below, each city is represented by its first letter. Complete the adjacency matrix for the graph.

1 mark

		<i>to</i>							
		<i>C</i>	<i>D</i>	<i>G</i>	<i>H</i>	<i>J</i>	<i>M</i>	<i>N</i>	<i>W</i>
<i>from</i>	<i>C</i>	0	0	1	0	1	0	1	1
	<i>D</i>	0	0	0	1	1	0	1	0
	<i>G</i>	1	0	0	0	0	0	0	1
	<i>H</i>	0	1	0	0	1	0	1	1
	<i>J</i>	1	1	0	1	0	1	1	—
	<i>M</i>	0	0	0	0	1	0	1	0
	<i>N</i>	1	1	0	1	1	1	0	0
	<i>W</i>	1	0	1	1	1	0	—	0

SECTION B – Module 2 – Question 2 - continued

There are no direct flights from **Johannesburg (JHB)** to **Gaborone**.

- c. Write down the *shortest path* for this network, that gives the minimum total number of minutes for the flight times, from Johannesburg (JHB) to Gaborone.

I mark

Question 3 (3 marks)

As part of the preparation for the new airline Khosi's director needs to check the facilities at each of the airports. She would like to do this as one big trip, starting and finishing at Johannesburg, visiting each of the other airports only once.

- a. i. What is the mathematical name for this type of *walk*?

1 mark

- ii. Give one possible *walk* that will allow her to visit all the other airports only once, if she starts and finishes at Johannesburg (JHB).

1 mark

Another member of Khosi's management team needs to check each of the flight paths.

- a. This can be done without repeating any flight (in either direction) if she starts at **Dar Es Salaam**. Where would she finish the journey?

1 mark

SECTION B – Module 2 – continued

TURN OVER

Question 4 (2 marks)

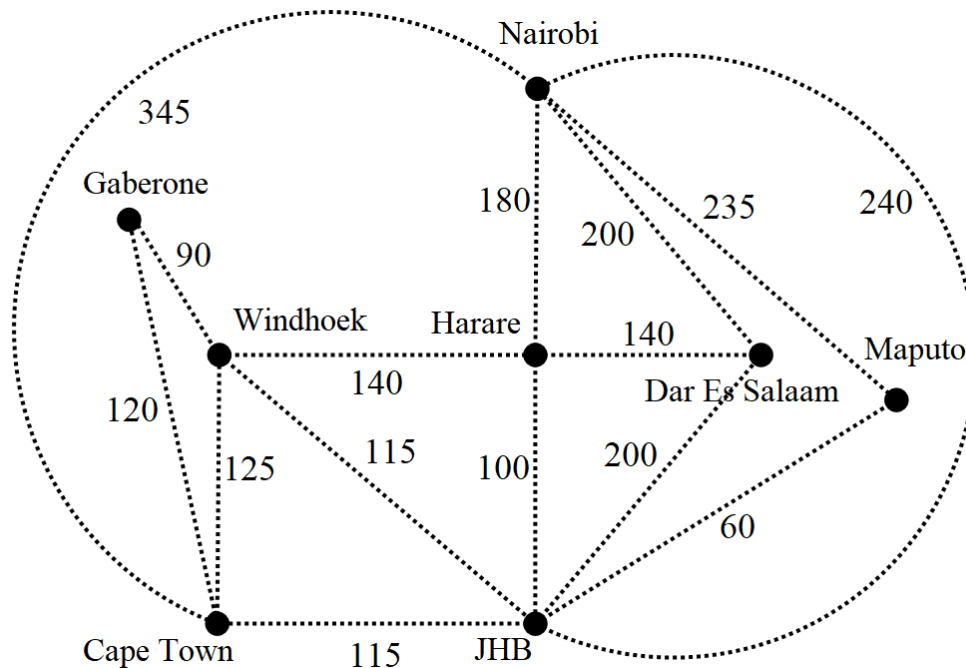
Initially, Khosi will only run the number of flights needed to connect the eight cities.

They choose the flights that give the minimum total flight times.

This can be represented as the **minimum spanning tree** for the network.

- a. Add the minimum spanning tree to the diagram below.

1 mark



- b. Calculate the weight of the minimum spanning tree for this network.

1 mark

END OF MODULE 2 – SECTION B – continued

Module 3: Geometry & Measurement**Question 1** (4 marks)

Narelle is a property owner who is living in a drought affected area.

Narelle is considering purchasing a large water tank to help drought proof her property.

One tank that Narelle considers is cylindrical. She will need to provide a circular concrete base for this tank.

- a.** The circular concrete base will have a radius of 4.5 metres.

What is the area of the circular concrete base? Give your answer, in square metres, correct to one decimal place. 1 mark

- b.** Narelle has ordered 8 m^3 of concrete.

How deep will the concrete base be? Give your answer in cm correct to one decimal place.

1 mark

- c.** The cylindrical tank has an internal radius of 4.2 metres and can hold water to a height of 2.2 metres.

Using an appropriate calculation, show that the tank can hold 121 919 litres of water correct to the nearest litre. 1 mark

SECTION B – Module 3 – Question 1 -continued

TURN OVER

Narelle could purchase a similar cylindrical tank that has a greater volume.

The larger tank is similar to the smaller tank, but all dimensions have been increased by 20%.

The volume of this tank can be determined by multiplying the volume of 121 919 litres by a number.

- d.** State the number that the volume of 121 919 litres can be multiplied by to obtain the volume of the larger tank. 1 mark

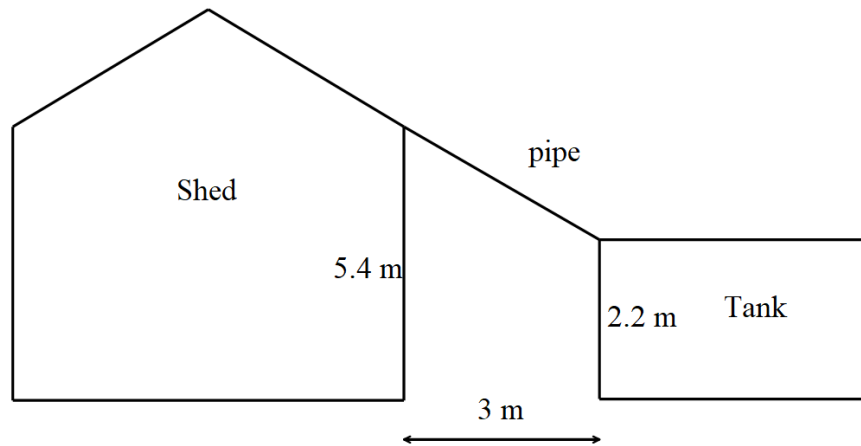
SECTION B – Module 3 – continued

Question 2 (3 marks)

Narelle's tank will collect water from her shed. The vertical sides of the shed are 5.4 metres high and the tank is 2.2 metres high. The shed and the tank are 3 metres apart on level ground.

A pipe takes water from the top of the vertical side of the shed to the top of the vertical side of the tank.

A diagram is shown below of the relative locations of the shed, pipe and the tank.



- a. What is the length of the pipe connecting the shed to the tank?

Give your answer in metres, correct to one decimal place.

1 mark

In order for the water to flow properly through the pipe, the angle of depression from the top of the shed wall to the top of the tank must be at least 12° .

- b. Show that the angle of depression of the pipe will provide adequate flow in this situation.

1 mark

SECTION B – Module 3 – Question 2 -continued

TURN OVER

- c. Narelle would prefer the tank to be further away from the shed. Given the minimum angle of depression required for adequate flow, what is the maximum distance that the shed could be located from the shed?

Give your answer in metres, correct to one decimal place.

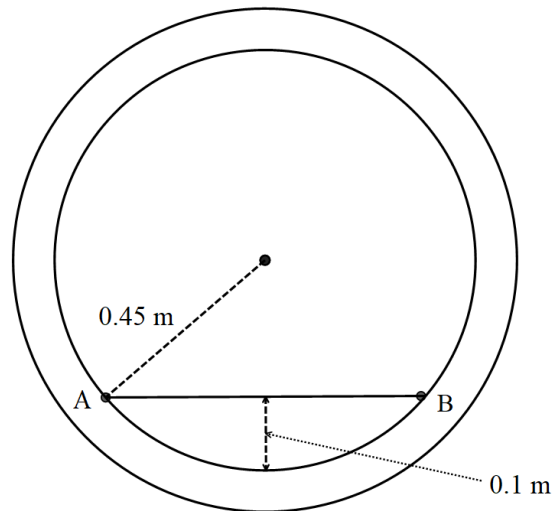
1 mark

SECTION B – Module 3 – continued

Question 3 (3 marks)

Narelle has a large drainage pipe on her property. The pipe has an internal radius of 0.45 metres.

After a large storm, there is water sitting in the bottom of the pipe. The depth of the water in the pipe is 0.1 metres. This is shown in the diagram below.



- a. Show that the length of the chord, AB, formed by the surface of the water is 57 cm, correct to the nearest whole centimetre. 1 mark

- b. What percentage of the cross sectional area of the pipe is filled with water?
Given your answer correct to the nearest whole percentage. 2 marks

SECTION B – Module 3 – continued

TURN OVER

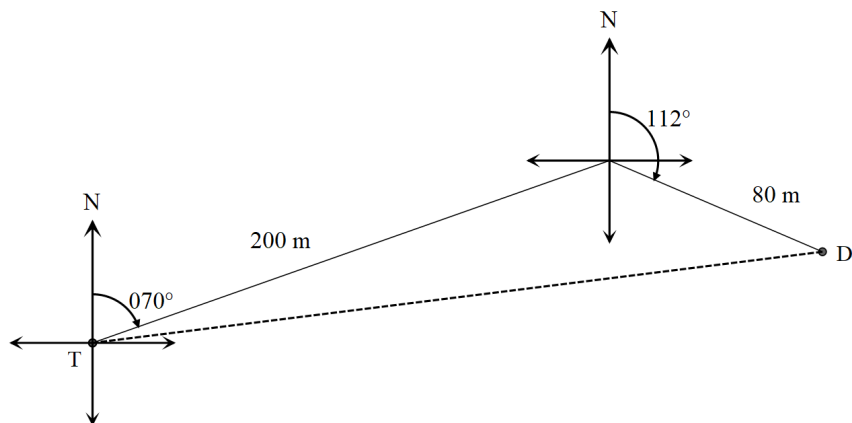
Question 4 (2 marks)

Narelle needs to direct some water from her tank (T) to a drinking trough (D) in another paddock.

Narelle has a 200 metre irrigation pipe that is placed on a bearing of 070° from the tank.

She then adds another irrigation pipe to the end of the first pipe. The second pipe is 80 metres long and it is placed on a bearing of 112° .

A diagram of these pipes and the location of the tank (T) and drinking trough (D) is shown below.



Narelle wants to place another pipe back from the drinking trough (D) to the tank (T) in case of overflow. This is shown as a dotted line from D to T on the diagram.

State the bearing that the return pipe will take from D to T.

Give your answer in degrees, correct to the nearest whole degree.

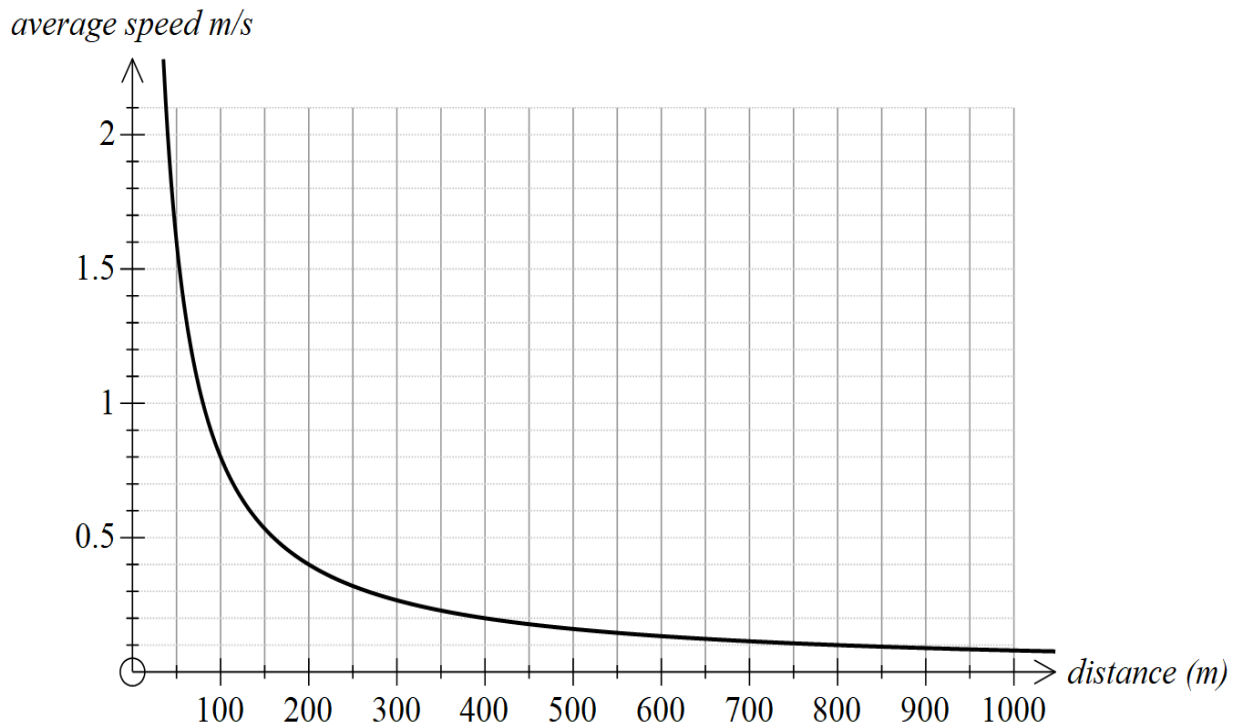
2 marks

END OF MODULE 3 – SECTION B – continued

Module 4: Graphs and Relations**Question 1** (2 marks)

Maggie is training for a ‘Half Distance Triathlon’ where she is required to swim 1.9km, ride 90km and run 21.1km.

The graph below shows the relationship between the *average speed* for the swim (in m/s) and the *distance* she swims (in metres).



- a. One day, Maggie swam 400m.

What was her average speed in metres per second?

1 mark

- b. The equation for the relationship between *average speed* and *distance* has the form

$$\text{average speed} = \frac{k}{\text{distance}}$$

Find the value of k .

1 mark

SECTION B – Module 4 – Question 1 - continued

TURN OVER

Question 2 (5 marks)

One day Maggie attempted a training run. The distance-time graph displays the journey, showing the *distance*, in km, that she is from home.

distance (kilometres)



- a. On her run she stopped for a rest when she was 7.2km from home.

How long, in minutes, was her rest?

1 mark

Maggie's father decided to meet Maggie to give her some more water.

He left home 15 minutes later than Maggie and travelled in the same direction.

- b. Maggie's father travelled at an average speed of 40km/h.

- i. What is his distance from home fifteen minutes after he leaves?

1 mark

- ii. On the axes provided above, draw a graph of the relationship between the father's *distance* from home, in kilometres, and the *time* (after Maggie left home), in hours.

(Answer on the graph above.)

1 mark

SECTION B – Module 4 – Question 2 - continued

- c. How far from home, correct to the nearest 10 m, was Maggie when she met her father?

2 marks

SECTION B – Module 4 – continued
TURN OVER

Question 3 (5 marks)

Maggie's coach insists that for her other training that she must spend time both cycling and swimming.

Let x be the number of hours she spends swimming and let y be the number of hours she spends cycling.

One of the constraints for her training can be written as Inequality 1 shown below:

$$\text{Inequality 1: } y \geq 2x$$

- a.** Explain why swimming for 10 hours and cycling for 10 hours would not satisfy Inequality 1.

1 mark

Other constraints set by her coach are

- She needs to spend at least 4 hours swimming each week.

$$\text{Inequality 2: } x \geq 4$$

- She must spend a minimum of 20 hours, in total, training for the swimming and cycling, each week, but she should spend no more than 30 hours training for the swimming and cycling, each week.

- b.** Write down the other inequalities for these conditions

1 mark

She must spend a minimum of 20 hours, in total, training for the swimming and cycling, each week.

Inequality 3: _____

She should spend no more than 30 hours, in total, training for the swimming and cycling, each week.

Inequality 4: _____

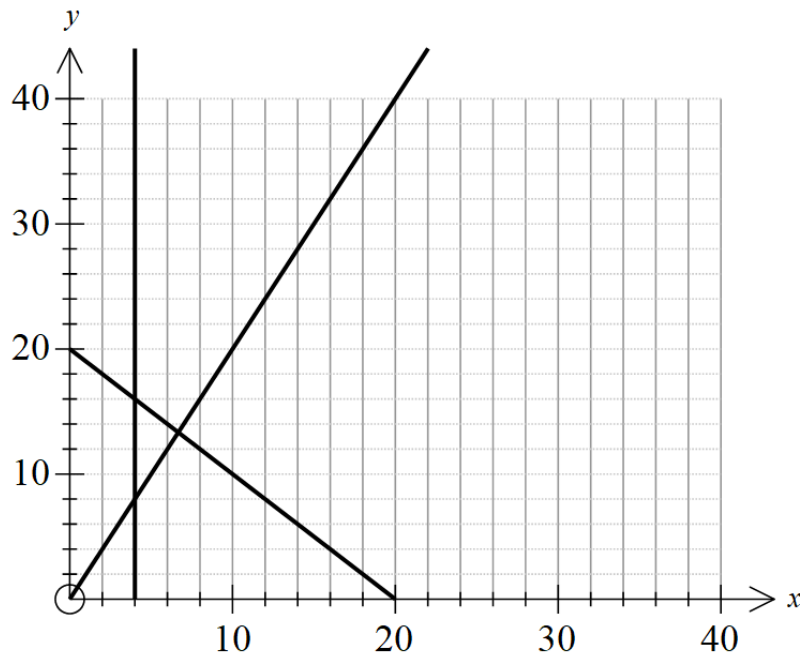
SECTION B – Module 4 – Question 3 - continued

The graph shows the boundaries for Inequalities 1, 2 and 3.

- c. Add the boundary for Inequality 4 to the graph

(Answer on the graph below.)

1 mark



- d. On the graph, shade the region that contains the points that satisfy the four inequalities.

(Answer on the graph above)

1 mark

- e. Find the minimum time that Maggie could spend cycling each week and still satisfy her coach's constraints.

1 mark

END OF QUESTION AND ANSWER BOOK