TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

External Assessment 2023

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GENERAL MATHEMATICS

MTG315123

Section A Bivariate Data Analysis

Pages: 16
Questions: 5
Information Sheet: 1

Preparation time for this exam: 15 minutes

Suggested working time: 48 minutes

Instructions:

- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
  - Spare diagrams have been provided at the end of each section. Indicate using the box provided if you have used the spare diagram.
- TASC approved calculators are allowed.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 48 minutes**.
- The General Mathematics Information Sheet can be used throughout this exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criteria.

Marker use	
C5	/ 36
C3	/ 12

Guide to Exam Structure

	Parts	Questions available	Questions to answer	Suggested working time	Marks available
Section A		5	5	48 minutes	48 marks
Section B		5	5	48 minutes	48 marks
Section C		5	5	48 minutes	48 marks
Section D	Part 1 OR	4	4	36 minutes	36 marks
	Part 2	5	5	36 minutes	36 marks
Totals		**24**	**19 or 20**	**180 minutes (3 hours)**	**180 marks**

Criteria

You **must** make sure your answers address:

- Criterion 3 apply mathematical and statistical models to investigate, represent and analyse real-world situations and solve problems
- Criterion 5 interpret concepts and apply mathematical techniques to solve problems involving bivariate data analysis and time series analysis using the statistical investigation process.

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Question 1 (approximately 6 minutes)

Marker use

A city council surveys local business owners and local residents to gauge their opinion on a multi-storey hotel development that is proposed for a prime waterfront site.

	Local Residents	Local Business Owners	Total
In favour of the development	401	122	523
Against the development	589	12	601
Total	990	134	1124

Table 1

a) Convert the survey data into percentage form in Table 2, and display it on the segmented bar chart in Figure 1.

C5

/4

	Local Residents %	Local Business Owners %
In favour of the development		91.0
Against the development		9.0
Total	100	100

Table 2

Question 1 continues

Marker use

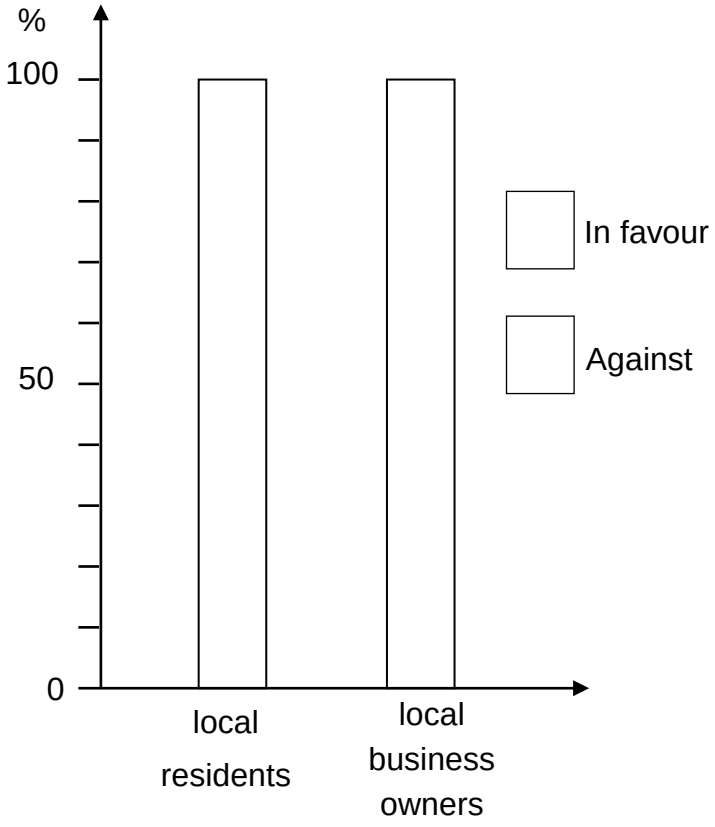

Figure 1: Graph for answering Question 1 a).

Spare diagram used (X) ☐

b) Use the survey data to support the case in favour of the hotel development.

C3 /1

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c) Use the survey data to support the case against the hotel development.

C3 /1

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Total C5 /4

Total C3 /2

Question 2 (approximately 9 minutes)

Marker use

Six (6) zucchini plants are grown in the same greenhouse, but each is given a different amount of fertiliser. The total harvest (in kg) of zucchini from each plant is shown in the data in Table 3 and Figure 2.

	Amount of fertiliser (g)	Amount of harvest (kg)	XY	X^2
	10	1.5	15	100
	20	1.9	38	400
	30	2.8	84	900
	40	2.9	116	1600
	50	3.7		
	60	3.9		
Totals	210	16.7	672	

Table 3

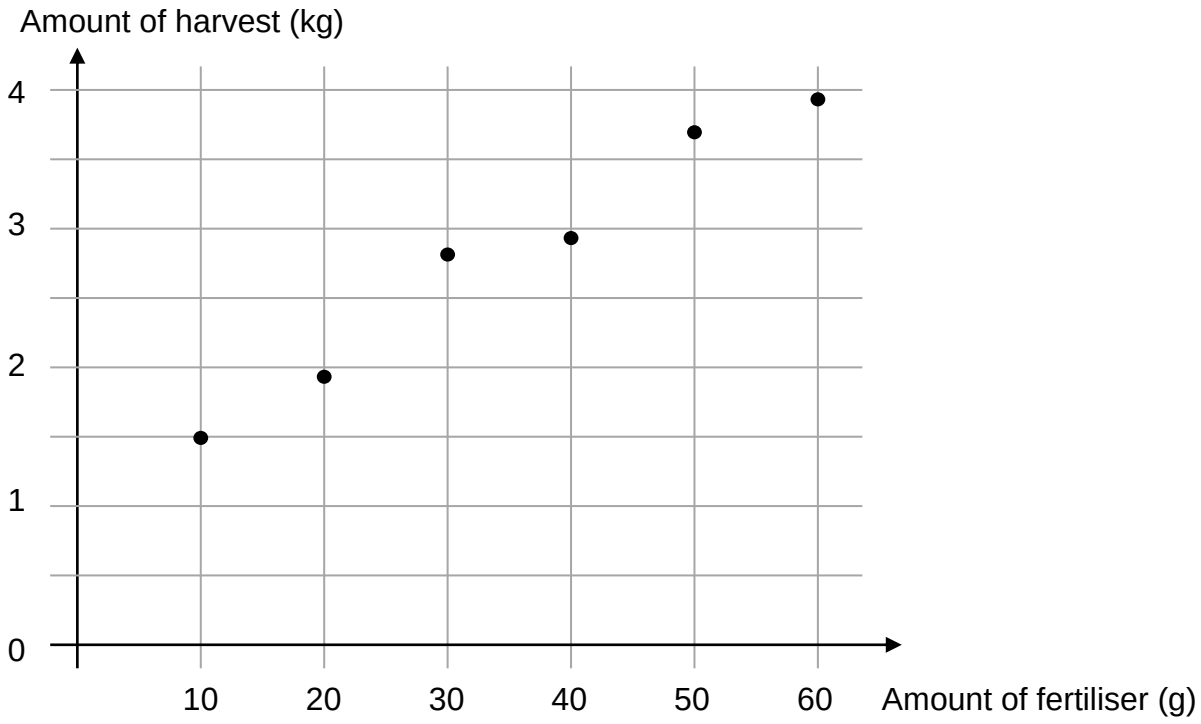

Figure 2: Graph for answering Question 2 b).

Spare diagram used (X) ☐

Question 2 continues

Question 2 continued

Marker use

a) Complete the data in Table 3 and use a formula to determine the linear relationship between amount of fertiliser (f) and size of the zucchini harvest (Z). Express numbers to two (2) decimal places.

C5 /4

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b) Use your equation to find **two** points on the regression line and use them to locate the regression line on Figure 2.

C5 /3

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c) Use your equation to estimate the amount of fertiliser necessary to produce a harvest of 3.2 kg of zucchinis.

C5 /2

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Total C5 /9

Question 3 (approximately 9 minutes)

Marker use

The manager of a swim centre finds that there is a linear relationship between the number of swimmers using the facility each day and the water temperature of the pool, as shown by Figure 3.

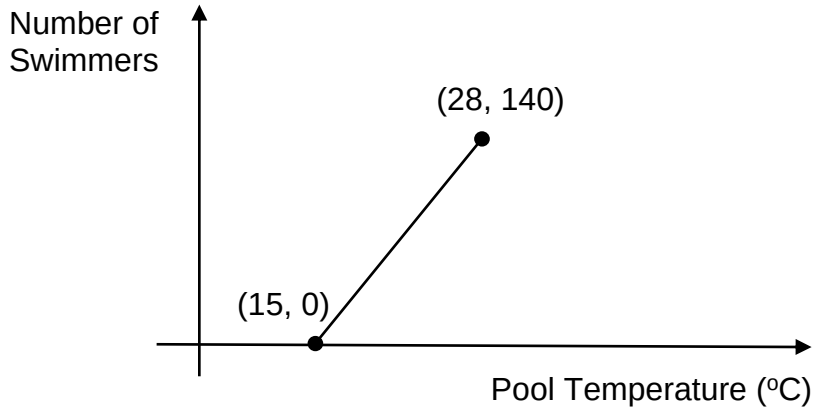

Figure 3: Graph of number of swimmers against pool temperature (℃).

a) What is the gradient of the line? (Include units in your answer.)

C5

/2

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b) What does the gradient represent?

C3

/1

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c) What does the 'x' intercept represent?

C3

/1

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Question 3 continues

Marker use

d)

i. Why does the relationship become irrelevant for water temperatures of less than 15°C?

C3 /1

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ii. How many swimmers would actually be expected when the water temperature is less than 15°C?

C3 /1

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e) What do you suppose might happen to pool attendance for water temperatures of above 28°C? Illustrate your answer by including a sketch graph.

C3 /2

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f) The manager charges swimmers $4 for pool entry.

A graph is drawn showing the daily takings (in $) against the temperature of the pool (for temperatures between 15°C and 28°C). Which of the following would be true if this graph was compared with Figure 3 at the start of this question?

C3 /1

Tick **the one (1)** correct answer:

☐ Its gradient and y intercept would be unchanged.

☐ The whole graph would be moved up 4 units.

Total C5 /2

☐ Its gradient would be multiplied by 4 but it would have the same y intercept.

Total C3 /7

☐ Its gradient would be multiplied by 4 but it would have the same x intercept.

Question 4 (approximately 14 minutes)

Marker use

Table 4 and Figure 4 give information about the length of each of the yachts in an ocean race and the time they took to complete the race.

	Yacht Name	Yacht Length (m)	Time taken to complete race (min)	Residual (min)
A	*Gravy Train*	26.5	1230	98.4
B	*Constellation*	25.8	1200	21.4
C	*Grace*	18.4	1420	-255.4
D	*Helter Skelter*	17.0	1830	
E	*Box Seat*	16.2	1613	-210.2
F	*Fire Fly*	14.7	1950	26.1
G	*Unshackled*	12.6	2435	370.1
H	*Bondi Bullet*	10.2	2115	-111.0

Table 4

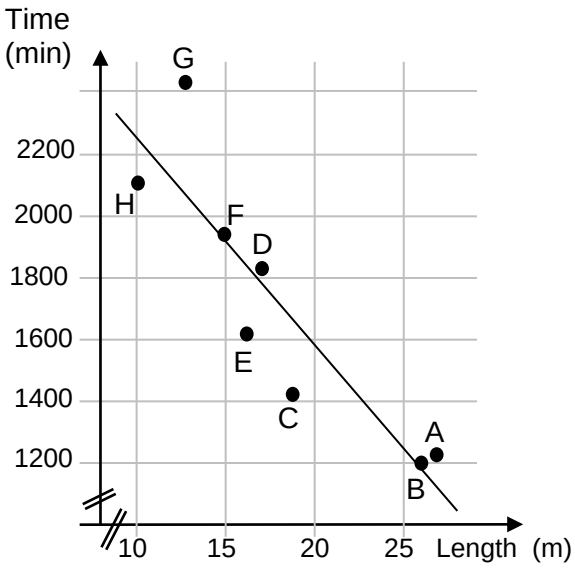

Figure 4 a: Graph of time taken against yacht length.

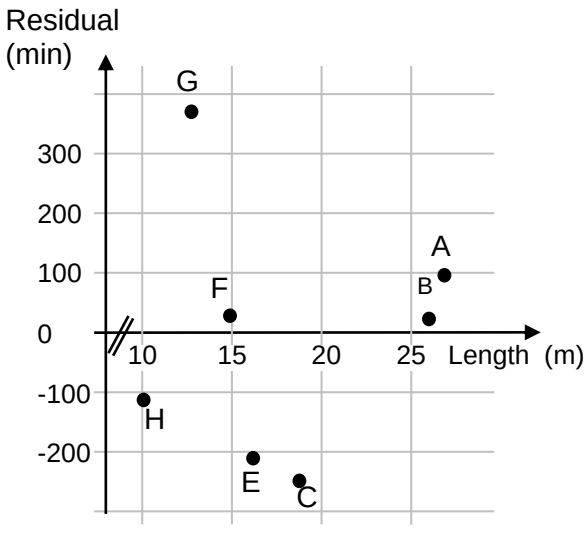

Figure 4 b: Graph of residual time against yacht length.

Spare diagram used (X) ☐

a) Use your calculator to find the equation of the linear relationship between time taken to complete the race (T) and the length of the yacht (L). Express numbers to one (1) decimal place.

C5

/2

.....

Question 4 continues

Marker use

b) Find the correlation coefficient and interpret it in terms of the variables.

C5 /3

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c) The residual for *Helter Skelter* is missing from the data in Table 4 and Figure 4 b.

i. Use your equation to predict the time taken for *Helter Skelter* to finish the race.

C5 /1

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ii. Use this to find the residual time for *Helter Skelter* and plot it on the residuals graph.

C5 /3

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iii. State in words what this residual means.

C3 /1

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In ocean sailing there are often two (2) trophies presented:

- the 'line honours winner' awarded to the first yacht home
- the 'handicap winner' awarded to the boat who performed best for its size.

d) Which boat would have been the line honours winner?

C5 /1

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e) Explain how residual analysis could be useful in determining the handicap winner.

C3 /2

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C5 /1

f) Which boat should be the handicap winner?

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Total C5 /11

Total C3 /3

Question 5 (approximately 10 minutes)

Marker use

A shop sells specialist bushwalking equipment. The data in Table 5 and Figure 5 give information about the profit of the shop, both in raw and seasonally adjusted terms.

	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring	Summer	Autumn	Winter	Spring
Quarter	1	2	3	4	5	6	7	8	9	10	11	12
Profit (x $1000)	62	52	30	48	64	51	18	48	70	58	32	52
Deseasonalised Profit (x $1000)	46.2	47.2	55.4	47.3	47.7	46.3	33.2	47.3				

Table 5

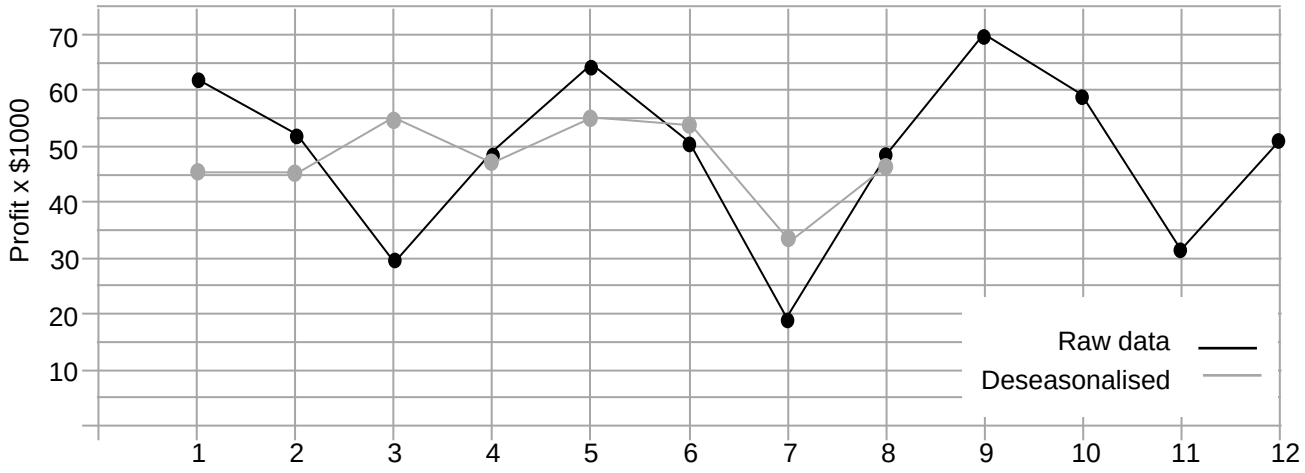

Figure 5: Graph of profits (x $1000) against quarter.

Spare diagram used (X) ☐

Some seasonal indices are shown in Table 6:

	Quarter			
	Summer	Autumn	Winter	Spring
Index	1.342	1.101		1.014

Table 6

Question 5 continues

Question 5 continued

Marker use

a) What is a seasonal index?

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C5 /1

b) Find the index for Winter (Table 6).

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C5 /2

c) Use the seasonal indices to complete the deseasonalised data in Table 5.

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C5 /2

d) Complete the graph of deseasonalised data (Figure 5).

C5 /1

e) Which of the quarters (1 – 12) had the greatest sales in deseasonalised terms? Explain what this means.

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C5 /2

f) The next quarter (Q13) recorded a deseasonalised profit of $44 000. What was the actual profit?

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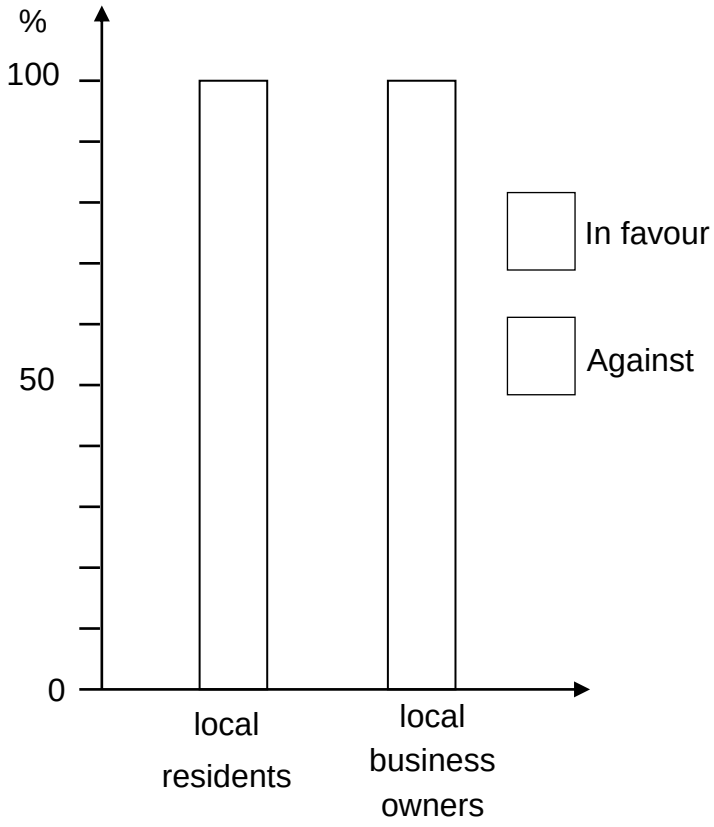
C5 /2

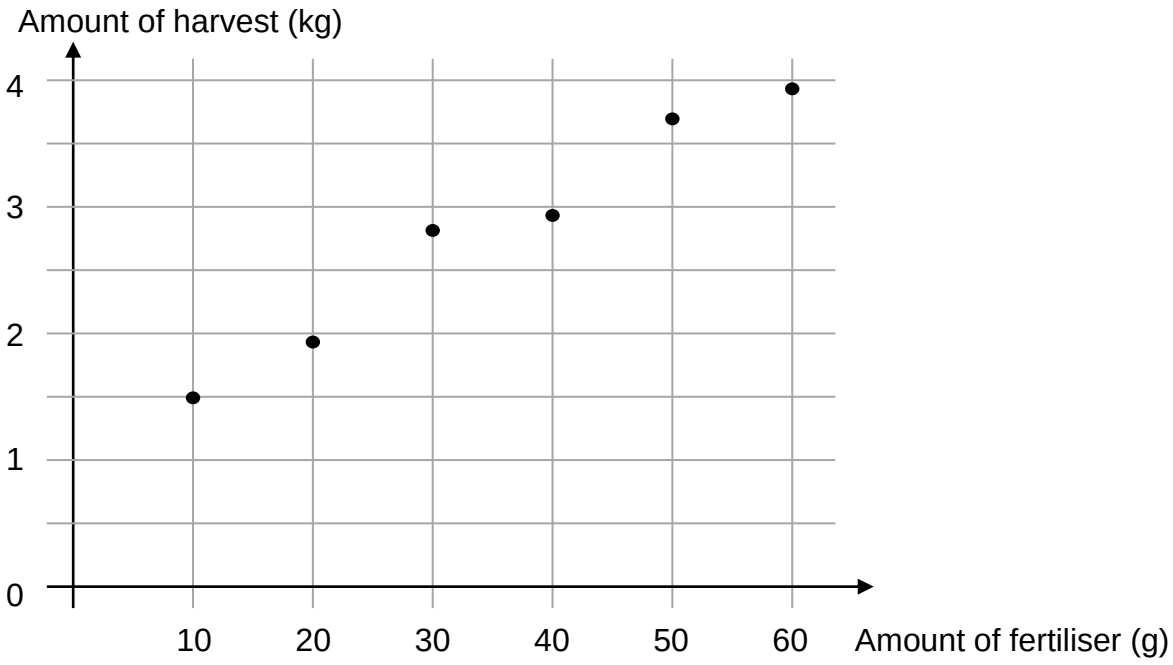
Total C5 /10

Spare Diagrams

Question 1 a)

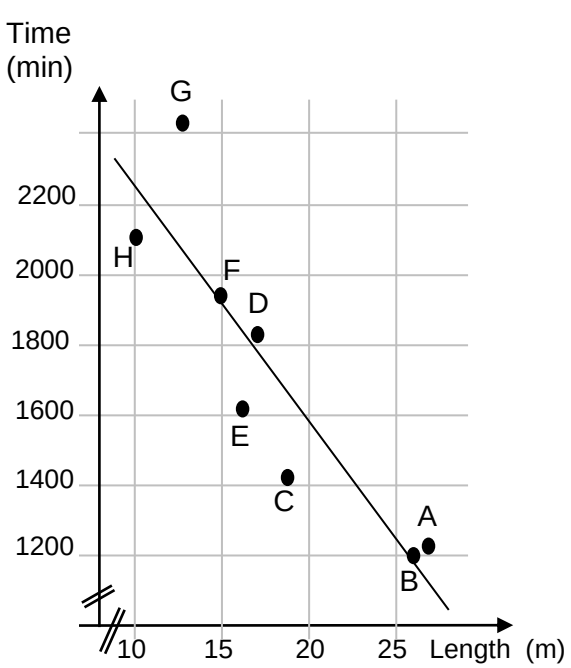


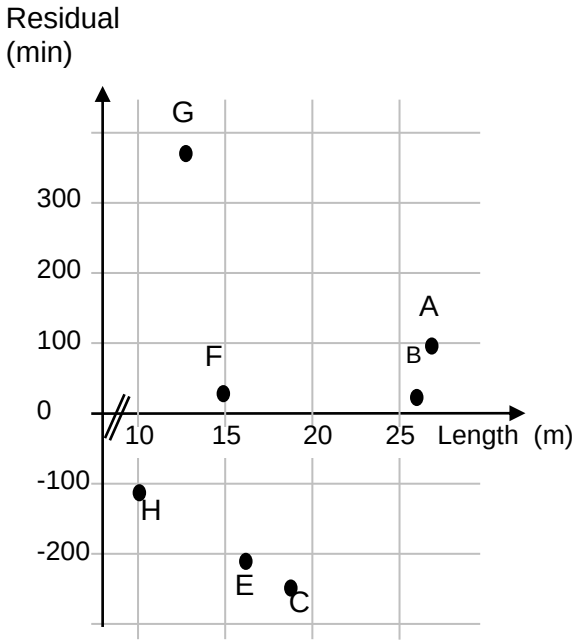
Question 2 b)



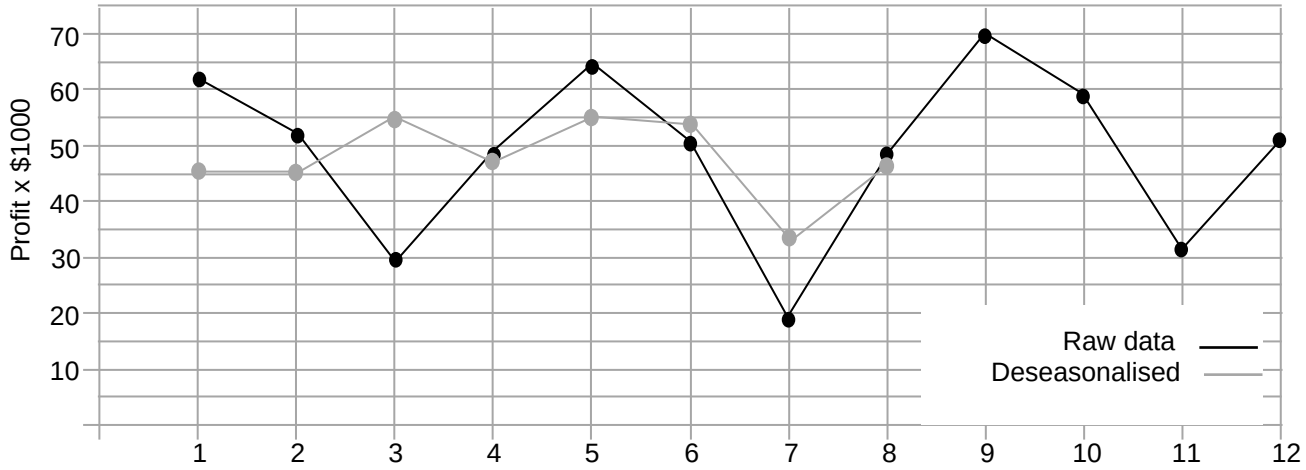
Spare Diagrams

Question 4 c)





Question 5 d)



End of Section A

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GENERAL MATHEMATICS

MTG315123

Section B Growth and Decay in Sequences

Pages: 12

Questions: 5

Information Sheet: 1

Suggested working time: 48 minutes

Instructions:

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Marker use	
C6	/ 36
C3	/ 12

Guide to Exam Structure

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Section C		5	5	48 minutes	48 marks
Section D	Part 1 OR	4	4	36 minutes	36 marks
	Part 2	5	5	36 minutes	36 marks
Totals		**24**	**19 or 20**	**180 minutes (3 hours)**	**180 marks**

Criteria

You **must** make sure your answers address:

- Criterion 3 apply mathematical and statistical models to investigate, represent and analyse real-world situations and solve problems
- Criterion 6 interpret concepts and apply mathematical techniques to model patterns and solve problems involving growth and decay in sequences.

Question 6 (approximately 7 minutes)

Marker use

A school has 800 students, but it is expected that the student population will grow by 15% every year. Consider the sequence formed by the annual student population.

C6 /2

a) Write the sequence rule and use it to generate the first four (4) terms.

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b) A stockpile of iron ore 560 m^3 in size is being moved by dump trucks which can carry 20 m^3 each load. Consider the sequence formed by the changing size of the pile.

C6 /2

Write the sequence rule and use it to generate the first four (4) terms.

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c) A bank account pays 2.5% p.a. interest, which is compounded annually. A deposit of $100 is made into the account. Every year the bank charges a $10 account keeping fee. Consider the sequence formed by the annual balance of the account.

C6 /2

Write a difference equation that models the sequence and use it to generate the first four (4) terms.

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d) Is the sequence generated in item c) arithmetic, geometric, or neither? Explain your answer.

C3 /1

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Total C6 /6

Total C3 /1

Question 7 (approximately 4 minutes)

Marker use

A new recruit has a salary package starting at $58 000, but with scheduled annual increases of $2100 for the next 10 years.

a) What mathematical term could be used to describe the sequence formed?

C3

/1

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b) Write, in algebraic form, a rule for the sequence.

C6

/1

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c) Find the salary in the 10^{th} year of work.

C6

/1

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d) Find the total paid to the recruit over the 10-year period.

C6

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Total C6

/3

Total C3

/1

Question 8 (approximately 7 minutes)

Marker use

A bushwalker who is attempting to reach a mountain cabin that is 34 km away walks:

- 6 km in the first hour
- 4.8 km in the second hour
- 3.84 km in the third hour.

a) Show that the terms form a geometric sequence.

C6 /1

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b) Find the distance walked in the 10^{th} hour.

C6 /1

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c) Find the total distance covered after 10 hours of walking.

C6 /1

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d) Will the walker ever reach his destination? (Assume that he can keep walking forever.) Support your answer with calculations.

C3 /2

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e) Given that the walker's rate of fatigue remains unchanged, find the minimum distance that he should have covered in the first hour to make reaching the cabin a possibility.

C6 /2

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Total C6 /5

Total C3 /2

Question 9 (approximately 13 minutes)

Marker use

The Murray River Cod is a native Australian freshwater fish. Last century the Murray River Cod was listed as endangered. The depletion of numbers was thought to be due to the introduction of another fish species – the European Carp. A program was introduced in 2010 to cull the numbers of European Carp. Figure 6 below shows how the estimated populations of both fish in a river reserve have changed since the introduction of the program.

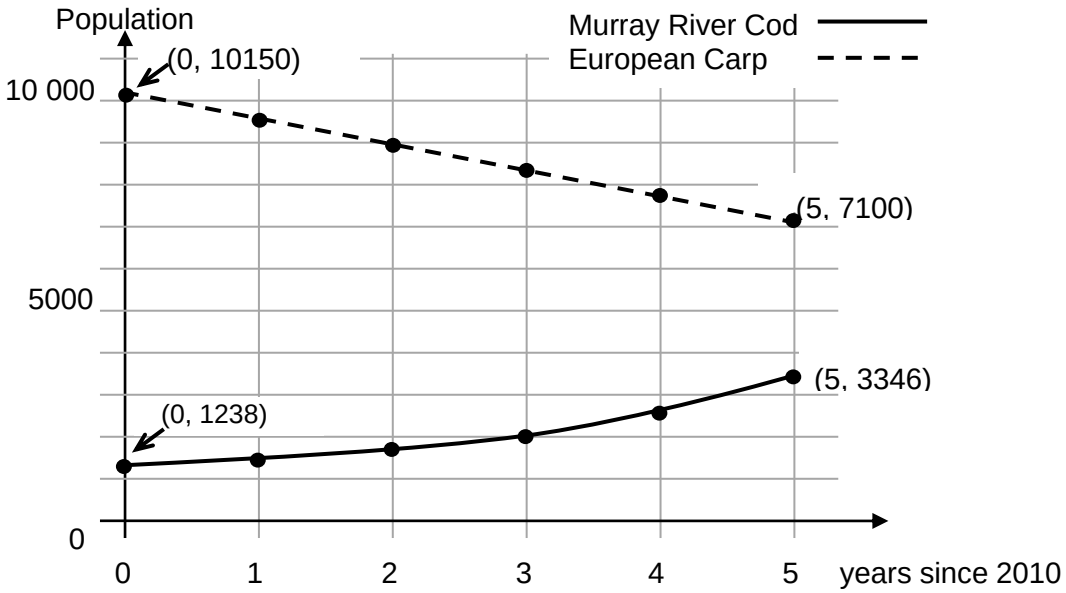

Figure 6: Graph of Murray River Cod and European Carp numbers.

a) What features of the graph show that:

i. Murray River Cod population numbers are showing exponential increase.

.....

C3 /1

ii. European Carp population numbers are showing linear decline.

.....

C3 /1

b) Show that the rate of exponential growth for the Murray River Cod is 22% p.a.

C6 /2

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Question 9 continues

Question 9 continued

Marker use

c) Find a difference equation that models the population numbers of Murray River Cod. Use initial term T_0 =

C6 /1

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d) Estimate the number of Murray River Cod in 2020.

C6 /1

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e) Find the annual rate of decline in European Carp numbers.

C6 /2

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f) Find a difference equation that models the population numbers of European Carp. Use initial term T_0 =

C6 /1

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g) Estimate the year when there will no longer be a population of European Carp.

C6 /1

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h) Find the year in which Murray River Cod numbers exceed European Carp numbers.

C6 /1

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i) Does the data show that removing European Carp has caused an increase in Murray River Cod numbers? Explain your answer.

C3 /2

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Total C6 /9

Total C3 /4

Question 10 (approximately 17 minutes)

Marker use

a) A lawn bowls club has 800 members, but each year its membership declines by 20%.

i. Write a difference equation for the situation. Use initial term T_0 =

C6 /1

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ii. Set up the difference equation on your calculator and use it to complete Table 7.

C6 /1

Years	0	5	10	15
Membership	800	262		

Table 7

iii. Describe what happens to membership numbers over time.

C3 /1

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b) A marketing analyst estimates that if the club promotes itself with television advertising 100 new members will join the club each year (while still losing 20% of the older members).

i. Write a difference equation for this situation. Use initial term T_0 =

C6 /1

.....

ii. Set up the difference equation on your calculator and use it to complete Table 8.

C6 /1

Years	0	5	10	15
Membership	800	598	532	

Table 8

iii. Describe what happens to membership numbers over time.

C3 /1

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.....

Question 10 continues

Marker use

c) The analyst estimates that if the club renovates the club rooms and conducts the television advertising then 240 new members will join each year (while still losing 20% of the older members).

i. Write a difference equation for this situation. Use initial term T_0 =

.....

C6 /1

ii. Set up the difference equation on your calculator and use it to complete Table 9 below.

C6 /1

Years	0	5	10	15
Membership	800	1069		

Table 9

iii. Describe what happens to membership numbers over time.

C3 /1

.....

.....

d) The club's committee decide that what they would really like is to attract just enough new members each year to replace the 20% of members who are leaving the club.

i. Write a difference equation for this situation. Use initial term T_0 =

C6 /2

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.....

.....

ii. What mathematical name is given to this type of situation?

C3 /1

.....

iii. Complete Table 10 below.

C6 /1

Years	0	5	10	15
Membership	800			

Table 10

Question 10 continues

Marker use

C6

/4

e) Complete Figure 7 showing the scenarios (a) to (d). Show clearly the shape of each graph and any asymptotes or limits.

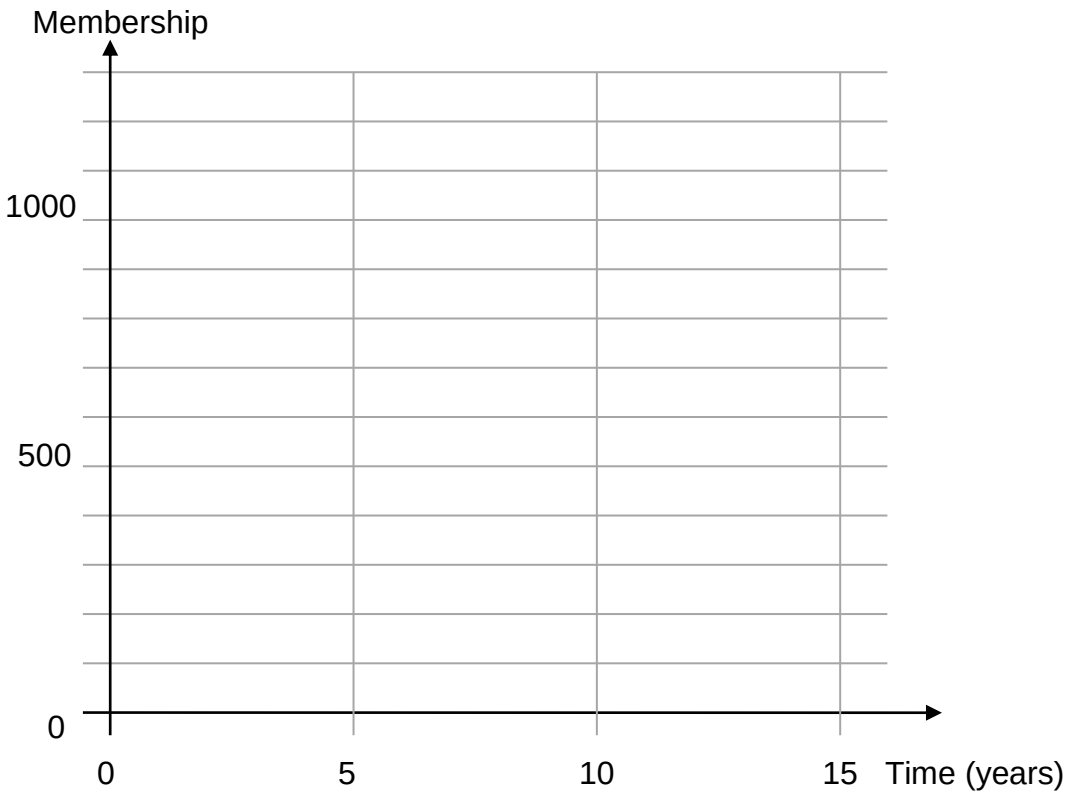


Figure 7: Graph for displaying scenarios a) to d) to answer Question 10 e).

Spare diagram used (X) ☐

Total C6

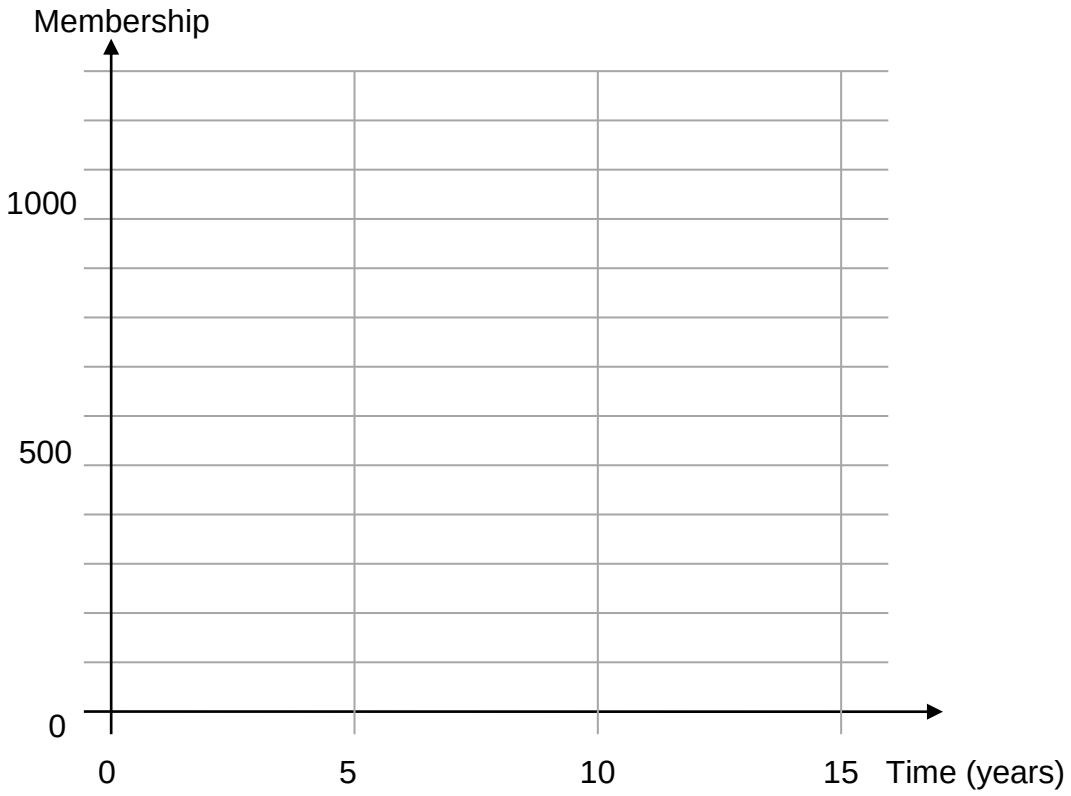
/13

Total C3

/4

Spare Diagrams

Question 10 e)



End of Section B

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GENERAL MATHEMATICS

MTG315123

Section C Finance

Pages: 12
Questions: 5
Information Sheet: 1

Suggested working time: 48 minutes

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Marker use	
C7	/ 36
C3	/ 12

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- Criterion 3 apply mathematical and statistical models to investigate, represent and analyse real-world situations and solve problems
- Criterion 7 interpret concepts and apply mathematical techniques to solve problems involving standard financial models.

Question 11 (approximately 7 minutes)

Marker use

Vanessa's credit card has an annual interest rate of 17.2% p.a. compounded daily. Before purchasing a laptop computer for $1350 Vanessa owed nothing on her credit card account. When Vanessa receives her account statement she notes that the minimum payment required is 3.5% of the balance – which she pays by the due date. When Vanessa gets her next statement she finds that she is charged 30 days interest on the outstanding balance.

a) How much interest was charged?

C7 /3

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b) What advice can you give Vanessa for avoiding interest fees on her credit card account?

C3 /1

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c) Use an algebraic formula to find the effective interest rate that Vanessa is paying on her credit card.

C7 /1

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d) Explain, with reference to this question, what is meant by the term 'effective interest rate'.

C3 /2

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Total C7 /4

Total C3 /3

Question 12 (approximately 6 minutes)

Marker use

The following interest factors in Table 11 can be used in situations where monthly compound interest on a loan is calculated:

Annuities in arrears interest factor table: $f = \dfrac{[1 - (1 + i)^{-n}]}{i}$

Present value of a $1 regular payment

	Interest rate per period	0.00083	0.00167	0.00250	0.00333	0.00417	0.00500	0.00583	0.00667
Number of periods	1	0.9992	0.9983	0.9975	0.9967	0.9959	0.9950	0.9942	0.9934
	2	1.9975	1.9950	1.9925	1.9900	1.9876	1.9851	1.9826	1.9802
	3	2.9950	2.9900	2.9851	2.9801	2.9752	2.9702	2.9653	2.9604
	4	3.9917	3.9834	3.9751	3.9669	3.9587	3.9505	3.9423	3.9342
	5	4.9875	4.9751	4.9627	4.9504	4.9381	4.9259	4.9137	4.9015
	6	5.9825	5.9652	5.9478	5.9306	5.9135	5.8964	5.8794	5.8625
	7	6.9767	6.9536	6.9305	6.9076	6.8848	6.8621	6.8395	6.8170
	8	7.9701	7.9403	7.9107	7.8813	7.8521	7.8230	7.7940	7.7652
	9	8.9626	8.9255	8.8885	8.8518	8.8153	8.7791	8.7430	8.7072
	10	9.9543	9.9089	9.8639	9.8191	9.7746	9.7304	9.6865	9.6429
	11	10.9452	10.8908	10.8368	10.7831	10.7299	10.6770	10.6245	10.5724
	12	11.9353	11.8710	11.8073	11.7440	11.6812	11.6189	11.5571	11.4958
	24	23.7518	23.5071	23.2660	23.0283	22.7939	22.5629	22.3351	22.1105
	36	35.4508	34.9131	34.3865	33.8708	33.3657	32.8710	32.3865	31.9118
	48	47.0335	46.0933	45.1787	44.2888	43.4230	42.5803	41.7602	40.9619
	60	58.5009	57.0524	55.6524	54.2991	52.9907	51.7256	50.5020	49.3184
	72	69.8543	67.7946	65.8169	63.9174	62.0928	60.3395	58.6544	57.0345
	84	81.0948	78.3243	75.6813	73.1593	70.7519	68.4530	66.2573	64.1593
	96	92.2235	88.6456	85.2546	82.0393	78.9895	76.0952	73.3476	70.7380
	108	103.2415	98.7628	94.5453	90.5718	86.8261	83.2934	79.9599	76.8125
	120	114.1499	108.6798	103.5618	98.7702	94.2814	90.0735	86.1264	82.4215
	240	217.4413	197.6740	180.3109	165.0219	151.5254	139.5808	128.9825	119.5543
	360	310.9072	270.5485	237.1894	209.4613	186.2818	166.7916	150.3076	136.2835

Table 11

Question 12 continues

Question 12 continued

Marker use

a) Use the interest factor table to find the amount borrowed over a 10-year loan period if monthly repayments of $1665.31 are made and the interest rate is 6% p.a. compounded monthly.

C7 /2

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b) Find the size of the monthly repayments on a loan of $200 000 taken over a 20-year period at 5% p.a. compounded monthly.

C7 /2

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c) How long would it take to repay $5000 if monthly repayments of $425.75 were made and the interest rate was 4% p.a. compounded monthly.

C7 /2

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Total C7 /6

Question 13 (approximately 10 minutes)

Marker use

An accountant is trying to determine the value of a wood-working machine which cost $9200 when new. It has an estimated lifetime of 8000 hours of operating time, after which it will be worthless.

a) Find an equation for the value of the machine if the accountant uses the unit cost method.

C7 /2

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b) Find the value of the machine after three (3) years if the machine is used for 910 hours in the first year, 360 hours in the second year and 570 hours in the third year of ownership.

C7 /1

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c) If a graph was drawn of the 'Value of the machine' against the 'Number of uses' it would be:

C3 /1

(Tick **the one (1)** correct answer)

☐ a straight line with 'y' intercept $9200 and gradient 1.15

☐ a graph made of several straight sections because it is used for differing amounts each year

☐ a straight line with 'y' intercept $9200 and 'x' intercept 8000

☐ a curved line indicating exponential decrease in value.

Question 13 continues

Question 13 continued

Marker use

Another way that the accountant may find the value of the machine is by using the straight line depreciation method.

d) Find the value of the machine after three (3) years if the accountant applies the straight line depreciation method based on 15% of its purchase price every year.

C7 /2

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e) Why do the two (2) methods give different valuations?

C3 /2

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f) Under what circumstances would you expect unit cost depreciation to give a lower valuation than straight line depreciation? Support your answer with calculations.

C3 /2

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Total C7 /5

Total C3 /5

Question 14 (approximately 11 minutes)

Marker use

A business has recently purchased a new vehicle that the management expect will last about 10 years. In preparation for replacing the vehicle, the business pays $2500 every quarter into an investment fund which pays 5.8% p.a. (compounding quarterly).

a) Use a difference equation to model the amount in the fund. Use initial term T_0 = C7 /2

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b) How much is in the fund after 10 years? C7 /2

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Instead, the company make an initial deposit of $10 000 into the account followed by the quarterly instalments of $2500.

c) Remodel the difference equation to reflect the new situation. Use initial term T_0 = C7 /2

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d) How much will be in the account after 10 years? C7 /1

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e) What would the present value of the investment's total be? C7 /2

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Question 14 continued

Marker use

f) Why is the concept of ‘present value’ useful in situations like this?

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C3

/2

Total C7

/9

Total C3

/2

Question 15 (approximately 14 minutes)

Marker use

Jude would like to buy a new car which would cost $32 000. She is considering two (2) options:

OPTION A SAVE TO BUY	OPTION B BORROW AND BUY NOW
By making a suitable deposit every month into an account paying 5.9% p.a. compound interest (compounding monthly) over a 3-year time frame. This option would mean that she would also have to allow for 3% p.a. increase in the price of the vehicle due to inflation.	Purchase the $32 000 vehicle by taking out a personal loan offering the following terms: • no deposit • monthly repayments at 8.2% p.a. (compounding monthly) for 3 years.

If Jude chooses to save to buy the car (Option A):

a) What would the expected price of the car be, allowing for the effects of inflation?

C7 /2

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b) What should her monthly savings payment be?

C7 /2

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c) How much will she pay for the car in total?

C7 /1

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Question 15 continues

Question 15 continued

Marker use

If Jude chooses to borrow to buy the car now (Option B):

d) Use an algebraic formula to show that the size of the loan repayment is $1005.72.

C7 /3

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e) How much will she pay in total for the car?

C7 /1

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f) List **two (2)** benefits of each option.

C3 /2

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Jude decides to follow option B (Borrow and Buy Now). After making payments for 12 months Jude thinks that she can pay the loan off more quickly.

g) Find the monthly payment required to pay off the remaining loan over the next 6 months.

C7 /3

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Total C7 /12

Total C3 /2

End of Section C

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GENERAL MATHEMATICS

MTG315123

Section D Networks **or** Trigonometry

Pages: 20

Questions: 9

Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

- There are **two (2)** parts to this section. Answer **all** questions in **one (1)** part. Either:
  - **Part 1** – networks and decision mathematics

    OR
  - **Part 2** – trigonometry and Earth geometry – Part 2 commences on page 14.
- Write your answers in the spaces provided in this exam paper.
  - Spare diagrams have been provided at the end of each section. Indicate using the box provided if you have used the spare diagram.
- TASC approved calculators are allowed.
- The exam is **three (3) hours** in length. The suggested working time for this section is **approximately 36 minutes**.
- The General Mathematics Information Sheet can be used throughout this exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C8	/ 36

Guide to Exam Structure

	Parts	Questions available	Questions to answer	Suggested working time	Marks available
Section A		5	5	48 minutes	48 marks
Section B		5	5	48 minutes	48 marks
Section C		5	5	48 minutes	48 marks
Section D	Part 1 OR	4	4	36 minutes	36 marks
	Part 2	5	5	36 minutes	36 marks
Totals		**24**	**19 or 20**	**180 minutes (3 hours)**	**180 marks**

Criterion

You **must** make sure your answers address:

- Criterion 8 interpret concepts and apply mathematical techniques to represent, analyse and solve practical problems in the two-dimensional plane.

Part 1 - Networks

Marker use

- **Either** answer **all** questions in this part **OR all** questions in Part 2.

Question 16 (approximately 11 minutes)

Figure 8 below represents the network of walking tracks that join campsites in a national park. The weights on the edges of the graph represent the length of each track in km.

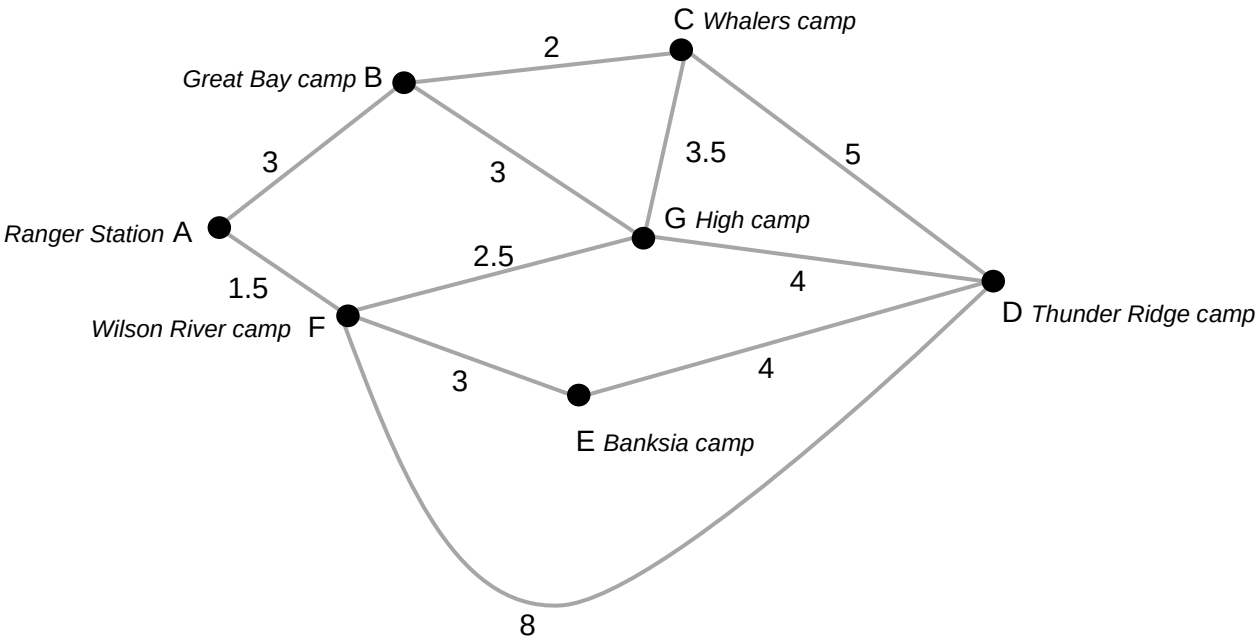

Figure 8: Graph of the network of walking tracks in a national park.

The ranger wishes to visit every campsite to check that they are clean. She wishes to do this without having to walk the same track twice, or visit the same campsite twice, and she wants to start and finish at the Ranger Station.

a) What mathematical name is given to this type of route?

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/1

Question 16 continues

Marker use

b) Give **two (2)** examples of such a route by marking them on the graphs below (Figure 9). /2

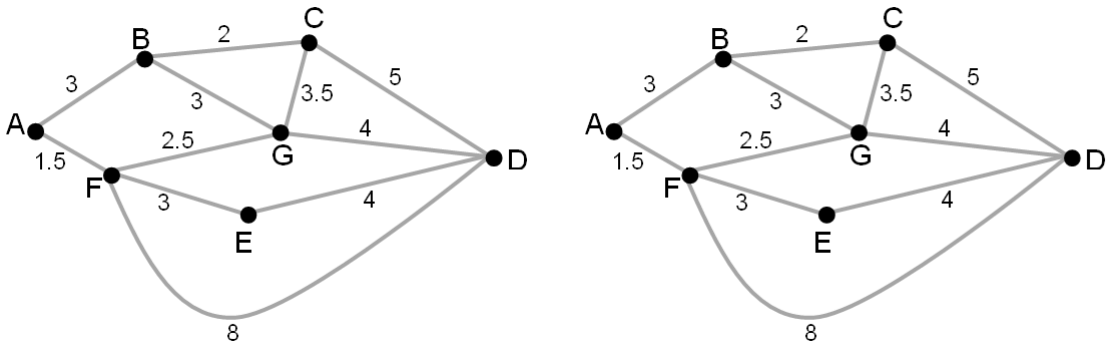

Figure 9: Graphs for providing two (2) example routes to answer Question 16 b).

Spare diagram used (X) ☐

c) Hence, find the length of the shortest route that the ranger should follow to accomplish her mission. /1

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On other occasions the ranger wishes to walk every track in the park to check that they are all in good condition. She wishes to do this without travelling the same track twice and wants to start and finish at the Ranger Station.

d) What mathematical name is given to this type of route?

..... /1

e) Is such a route possible? How can you tell?

..... /1

f) What is the shortest distance that the ranger would have to walk to be able to check all the tracks (starting and finishing at the Ranger Station)? /1

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g) Which track, if any, would need to be walked twice?

..... /1

Marker use

The management of the park want to upgrade some tracks so that all campsites can be reached via bicycle. They wish to do this in a way which minimises the total length of track that needs upgrading.

h) Mark the recommended sections for upgrade on Figure 10 below.

/2

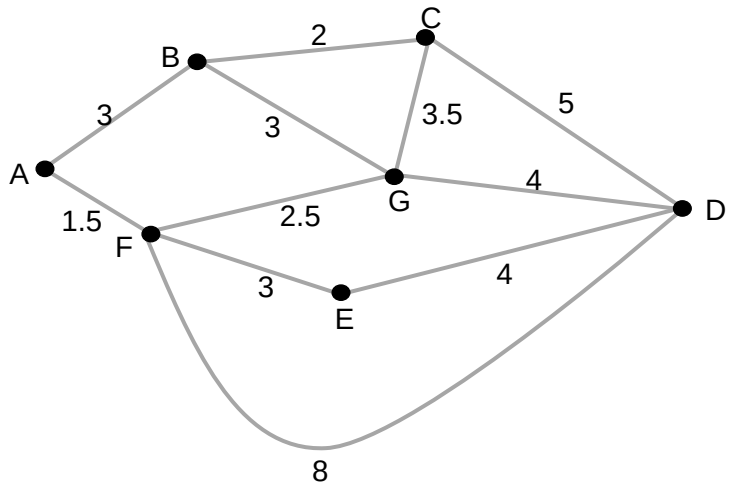

Figure 10: Graph for marking recommended sections to answer Question 16 h).

Spare diagram used (X) ☐

i) What is the minimum length of track that must be upgraded to meet bicycle use standards?

/1

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Total Q16

/11

Question 17 (approximately 9 minutes)

Marker use

At the end of a football game spectators must exit the grandstand. The weights on the graph below show the number of people per minute that can be moved through the different areas of a grandstand as it empties.

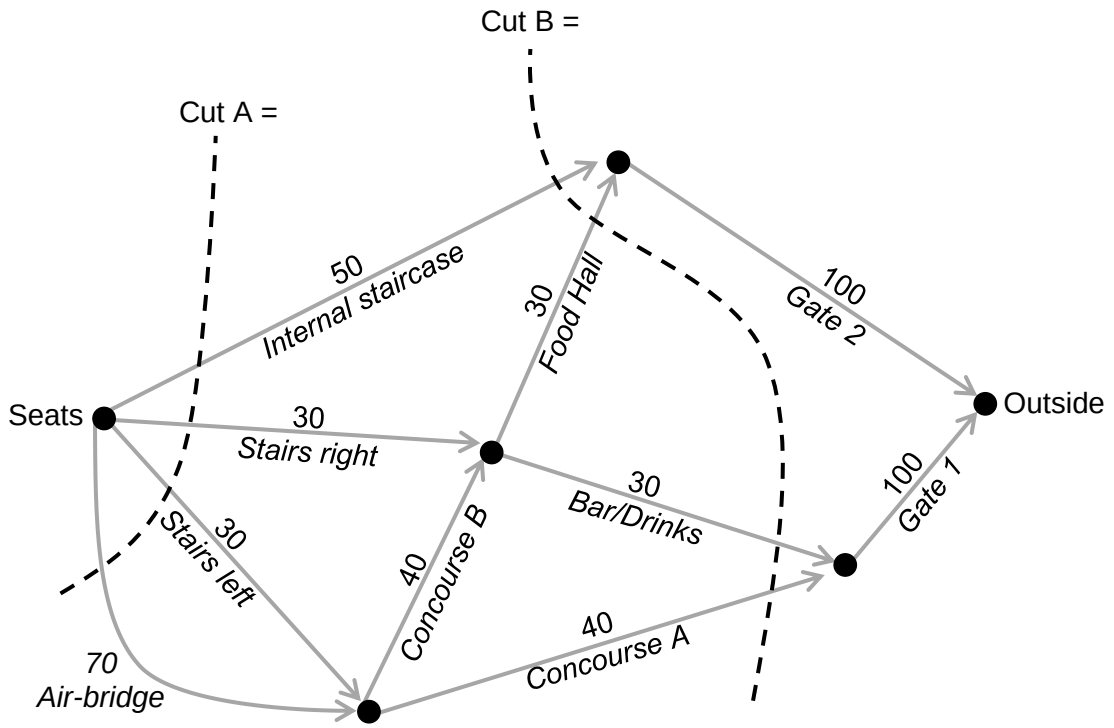

Figure 11: Graph showing the number of people per minute who can move through each grandstand section.

Spare diagram used (X) ☐

a) What is meant by the term 'cut' as it relates to a flow graph?

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/1

b) Find the capacity of cut A and cut B, and mark them on Figure 11.

/1

c) Draw **four (4)** more cuts and find the capacity of each.

/2

d) What is the maximum flow of people exiting the grandstand?

.....

/1

Question 17 continues

Marker use

e) Which of the following would be likely to produce a greater flow of people exiting the grandstand? Explain your answer:

- Widen the exit gates.
- Remove obstructions in the Food Hall.
- Put a high-speed travelator (conveyor belt) in the air-bridge, for people to walk on.

/2

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f) By how much would the overall flow through the network increase if the flow through the 'Drinks/Bar' area was increased to 50 people/min?
Explain your answer.

/2

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Total Q17

/9

Question 18 (approximately 9 minutes)

Marker use

A football club is building new locker rooms. The project manager is preparing a critical path analysis of the project and has prepared Figure 12. The weights represent the time taken for each activity in days.

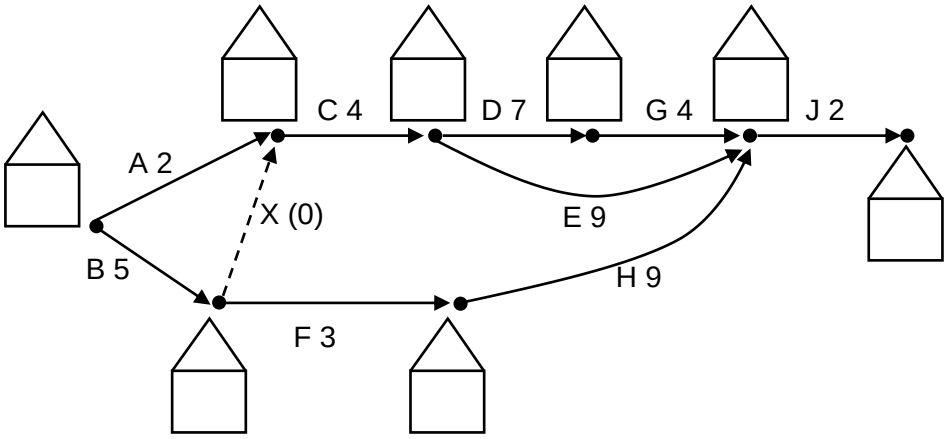

Figure 12: Critical path analysis for building locker rooms.

Spare diagram used (X) ☐

a) Explain why the dummy edge X had to be used between the end of B and the beginning of C. /2

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b) Find the EST and LFT for each activity and write them appropriately on Figure 12. /2

c) Mark the critical path on Figure 12. /1

d) What is the earliest completion time for the project? /1

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e) Find the 'float' involved in activity H. /1

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Question 18 continues

Marker use

/2

f) The project manager suggests that the builders could complete the project earlier by saving time on activity D. What is the maximum worthwhile saving of time on this activity? Explain your answer.

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Total Q18

/9

Question 19 (approximately 7 minutes)

Marker use

A factory manager wishes to minimise the time that it takes to manufacture items. He is considering allocating his four (4) workers so that each specialises in one of the four tasks that are involved in producing the item.

He times how long it takes each worker to do each of the tasks. The results are shown in Table 12 below.

	Time taken (minutes)			
	Case assembly	Motor installation	Electronics	Control panel
Allie	16	20	17	26
Bob	20	15	20	12
Chloe	12	20	17	14
Dave	20	15	10	13

Table 12

a) Use the Hungarian algorithm to reduce the matrix into a form where an assignment which minimises production time can be made.
(Start with row reduction first.)

/3

Spare diagram used (X) ☐

Question 19 continues

Marker use

b) Who should be assigned to each task?

/1

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c) What is the expected production time to produce one complete unit?

/1

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d) Find the amount of time saved per unit produced if task specialisation is introduced.

(Hint: To do this compare the time taken to produce four (4) units with the workers specialising against the time taken if they were working individually.)

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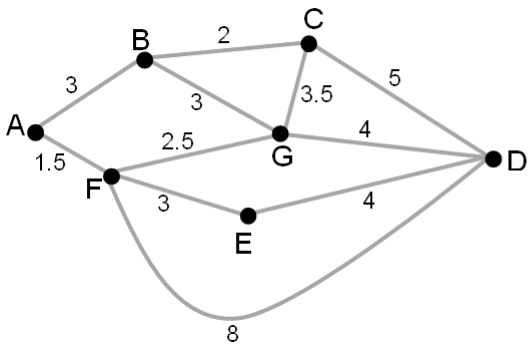
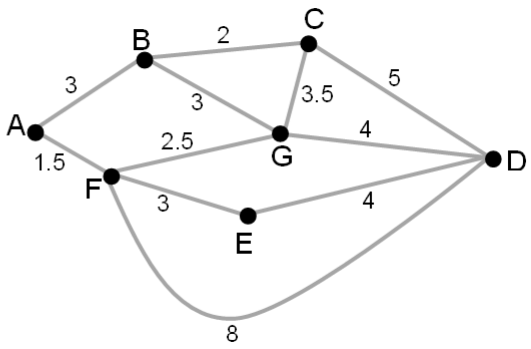
Total Q19

/7

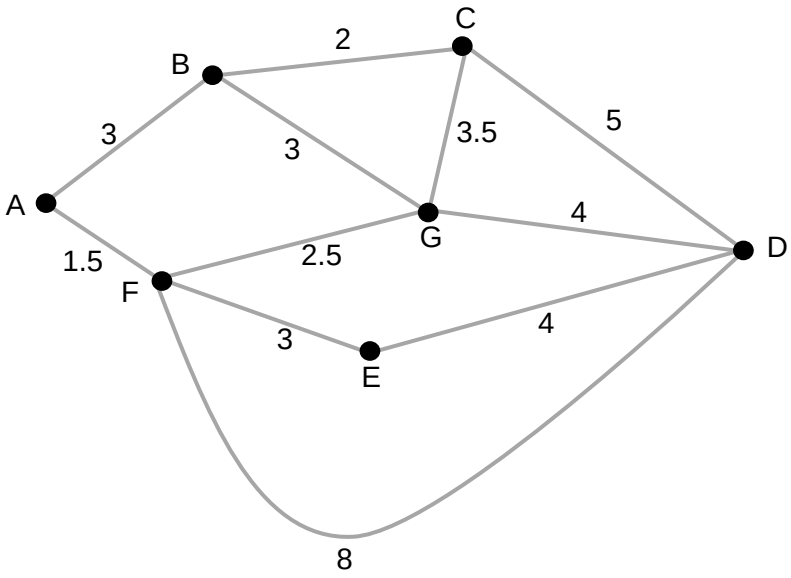
Spare Diagrams

Question 16 b)

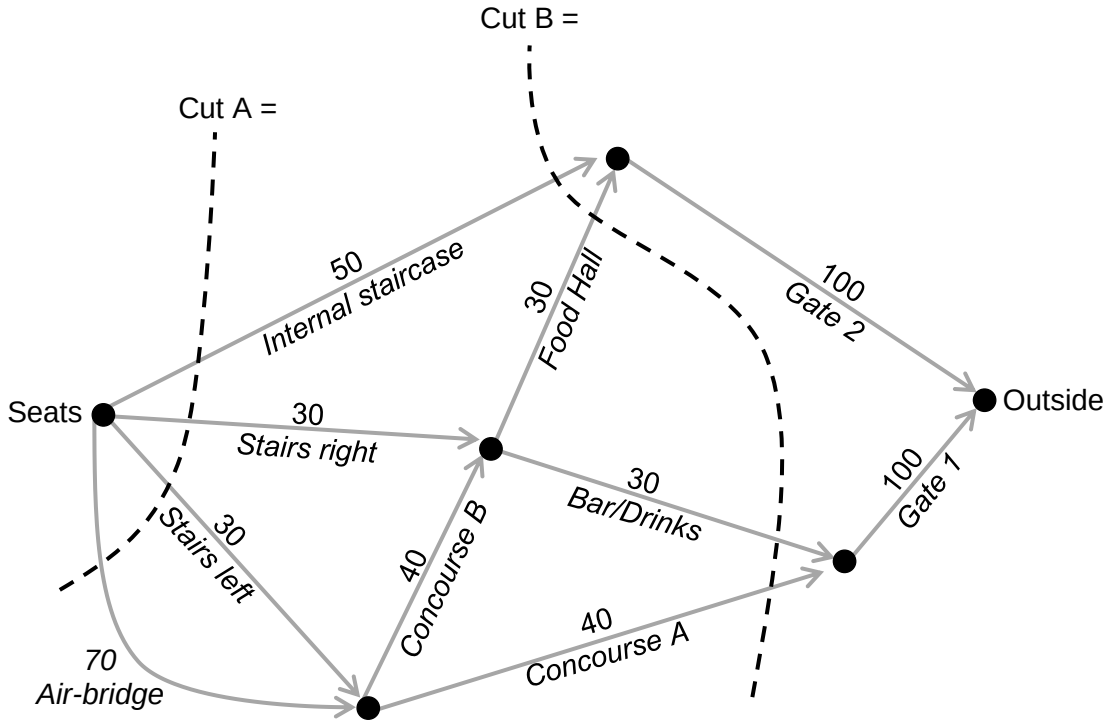




Question 16 h)

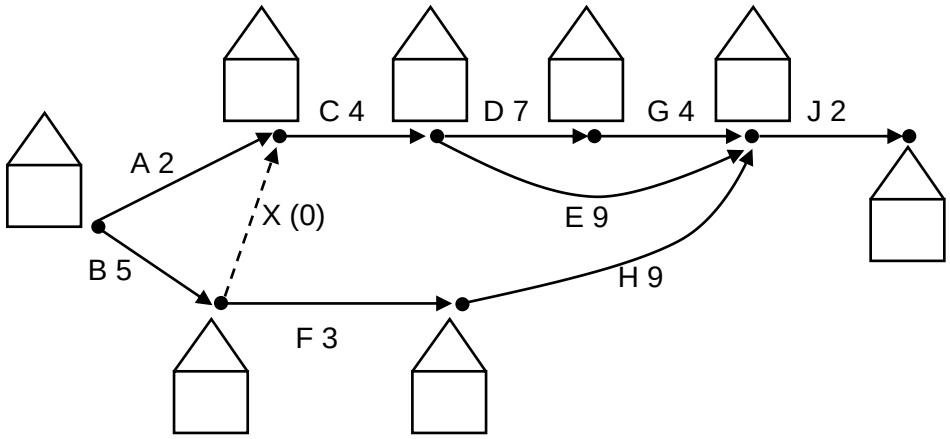


Question 17 b) and c)

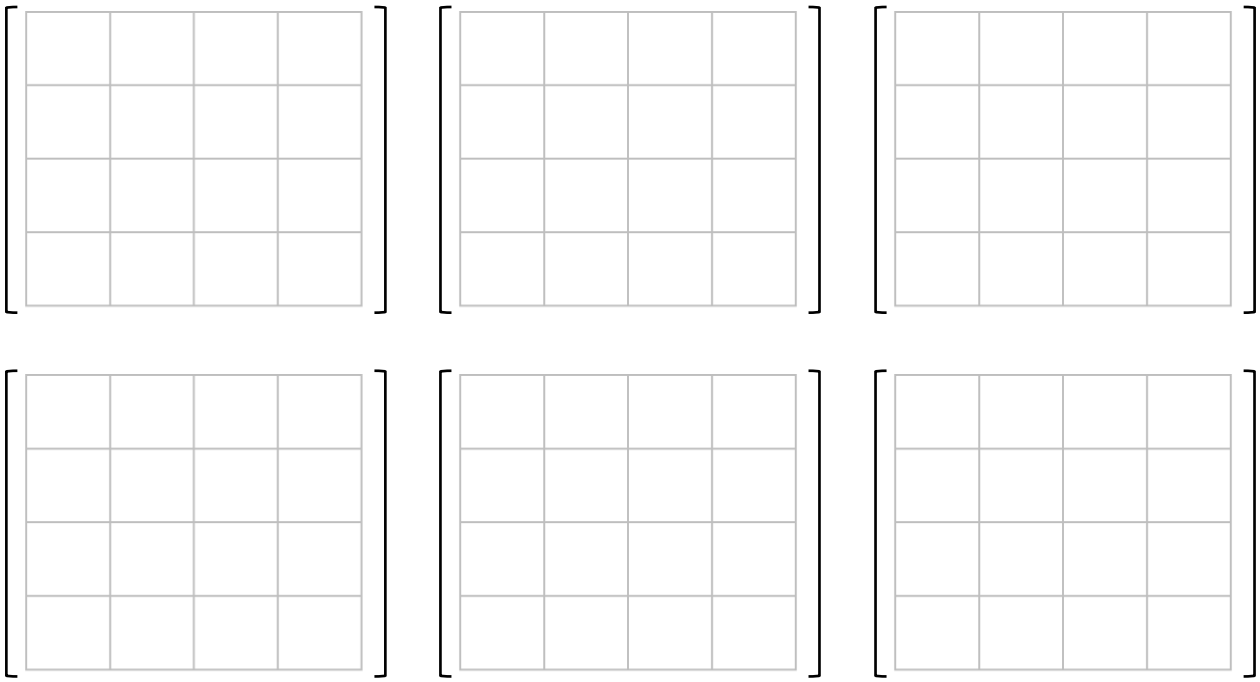


Spare Diagrams

Question 18 c)



Question 19 a)



End of Part 1

Part 2 - Trigonometry

Marker use

- **Either** answer **all** questions in this part **OR all** questions in Part 1.

Question 20 (approximately 7 minutes)

A surveyor who wishes to find the area of a block of land divides it into **two (2)** parts and makes measurements as shown by Figure 13.

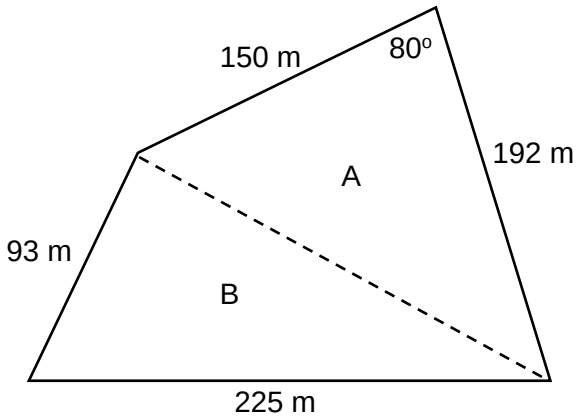


Figure 13: Diagram of a block of land divided into two (2) parts.

a) Find the area of triangle A.

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/2

b) Find the length of the dotted line.

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/2

c) Hence, find the area of triangle B.

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/2

d) Find the total area of the block of land**,** expressing your answer in **hectares**.
(1 ha = 10 000 m^2)

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/1

Total Q20

/7

Question 21 (approximately 7 minutes)

Marker use

From the top of a 120 metre high cliff the angle of depression to a small boat at sea is 29^o. After some time the observer notices that the boat has moved and the angle has become 65^o.

a) Draw a clear diagram that shows this information.

/3

b) Find the distance that the boat has moved between the two (2) observations.

/4

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Total Q21

/7

Question 22 (approximately 8 minutes)

Marker use

The bearing of a beacon on a rocky reef is N40°W when observed from a harbour 300 m away. The captain of a ship at sea identifies the beacon on a bearing S75°W and 420 m away.

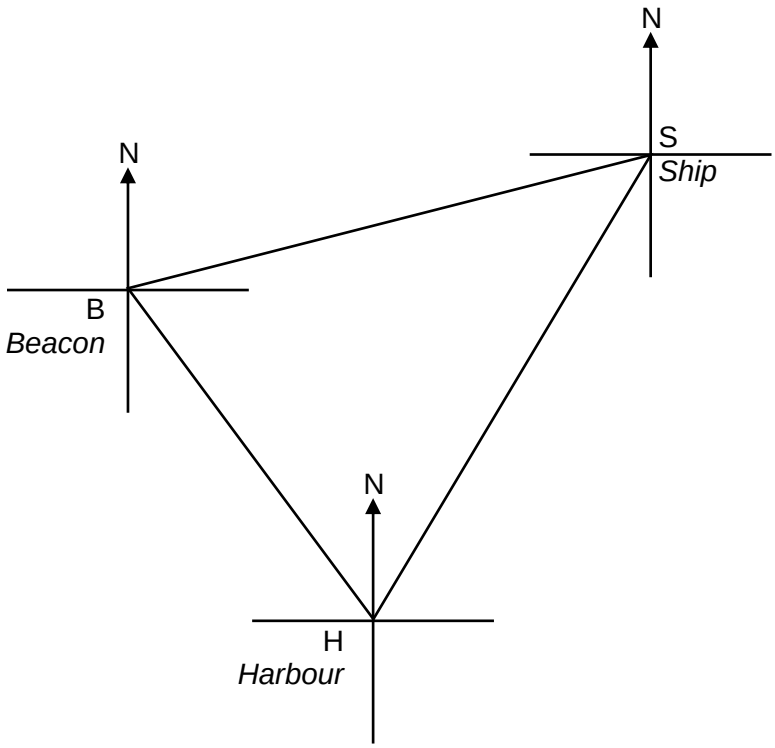

Figure 14: Diagram for marking bearings to answer Question 22 a).

Spare diagram used (X) ☐

a) Mark the bearings on Figure 14. /2

b) Find the distance of the ship from the harbour. /3

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c) On what bearing should the captain be heading to safely make the harbour? Answer to the nearest minute. /3

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Total Q22 /8

Question 23 (approximately 9 minutes)

Marker use

A jet leaves Perth (-31.95, 115.86) at 7:15 p.m. on Tuesday. It flies to Dubai (25.08, 55.31) by the shortest possible route and maintains a speed of 840 km/h. (Note: GPS bearings).

a) What is meant by the expression 'shortest possible route' in the context of distances on the surface of a sphere? /1

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b) Find the shortest distance from Perth to Dubai. /3

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c) Find the time zones (UTC) of Perth and Dubai. /2

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d) Find the estimated time of arrival (ETA) of the jet in Dubai. /3

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Total Q23 /9

Question 24 (approximately 5 minutes)

Marker use

Rome and Copenhagen are both situated on the same meridian of longitude.

Copenhagen has location 56ºN, 13ºE. It is 1557 km due North of Rome.

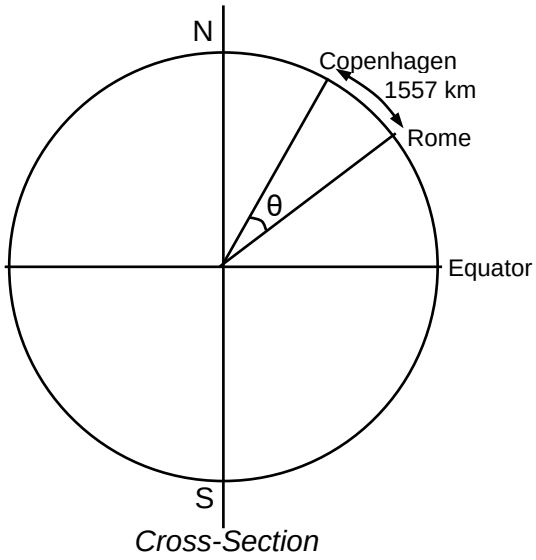

Figure 15: Diagram showing location of cities.

a) Find the angle θ subtended by the cities.

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/3

b) Hence find the co-ordinates of Rome. (Answer to the nearest whole degree.)

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/2

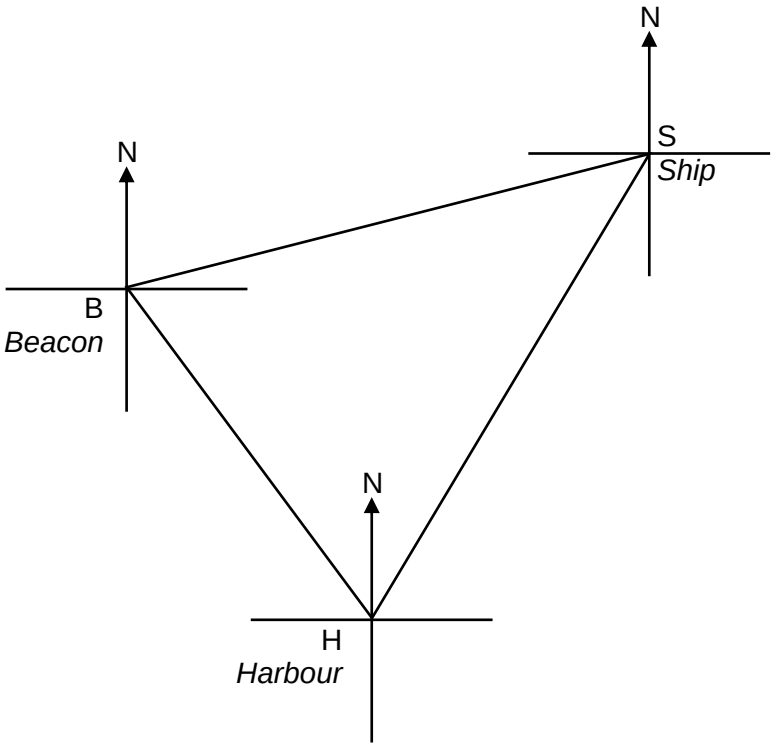
End of Part 2

Total Q24

/5

Spare Diagrams

Question 22 a)



End of Section D

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