TASMANIAN ASSESSMENT, STANDARDS & CERTIFICATION

External Assessment 2024

Attach your candidate label here

GENERAL MATHEMATICS

MTG315123

Section A Mathematical and Statistical Models

Pages: 12

Questions: 6

Information Sheet: 1

Preparation time for this exam: 15 minutes

Suggested working time: 36 minutes

Instructions:

- Answer **all** questions and **all** items within each question.
- Write your answers in the spaces provided in this exam paper.
- 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 the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C3	/ 36

Guide to Exam Structure

	Parts	Questions available	Questions to answer	Suggested working time	Marks available
Section A		6	6	36 minutes	36 marks
Section B		6	6	36 minutes	36 marks
Section C		6	6	36 minutes	36 marks
Section D		6	6	36 minutes	36 marks
Section E	Part 1 **OR**	6	6	36 minutes	36 marks
	Part 2	6	6	36 minutes	36 marks
Totals		**36**	**30**	**180 minutes (3 hours)**	**180 marks**

Criterion

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.

Question 1 (approximately 3 minutes)

Marker use

Figure 1 is a graph of actual and deseasonalised power costs for a Tasmanian household. The regression line for the deseasonalised data is also shown.

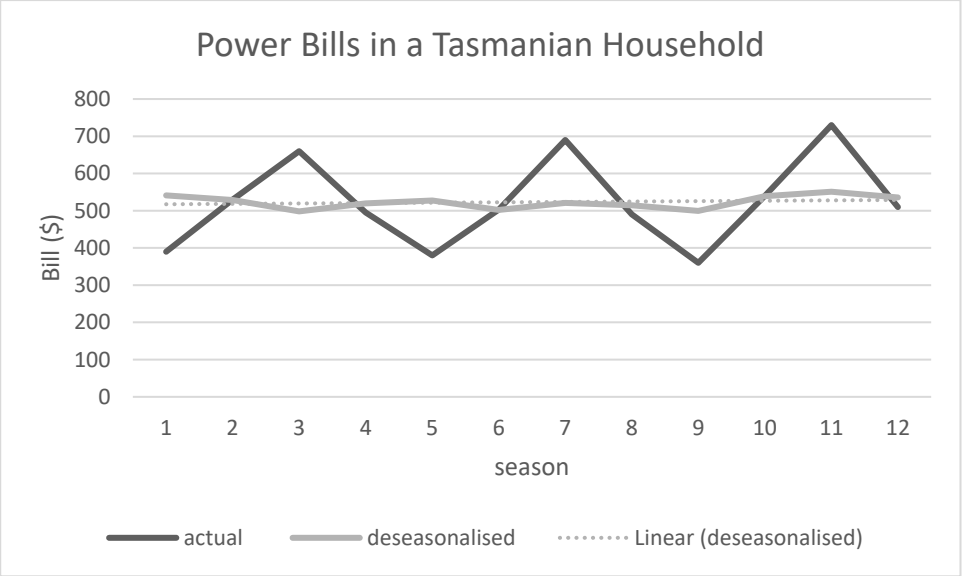

Figure 1: Graph showing power costs for a Tasmanian household.

a) What long term trend does the regression line of the deseasonalised data suggest?

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b) i. When using deseasonalised data to make predictions, the final step is to convert the deseasonalised prediction to actual. How is this achieved?

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ii. In what situation would a smoothing process, such as 3 or 5 point averaging, be used instead of deseasonalising?

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Total Q1

/3

Question 2 (approximately 9 minutes)

Marker use

A student hangs weights on a spring and measures the new length of the spring. Figure 2 shows the setup and a graph of the results. The linear model is $L = 4W + 5$, where L = length and W = the number of weights.

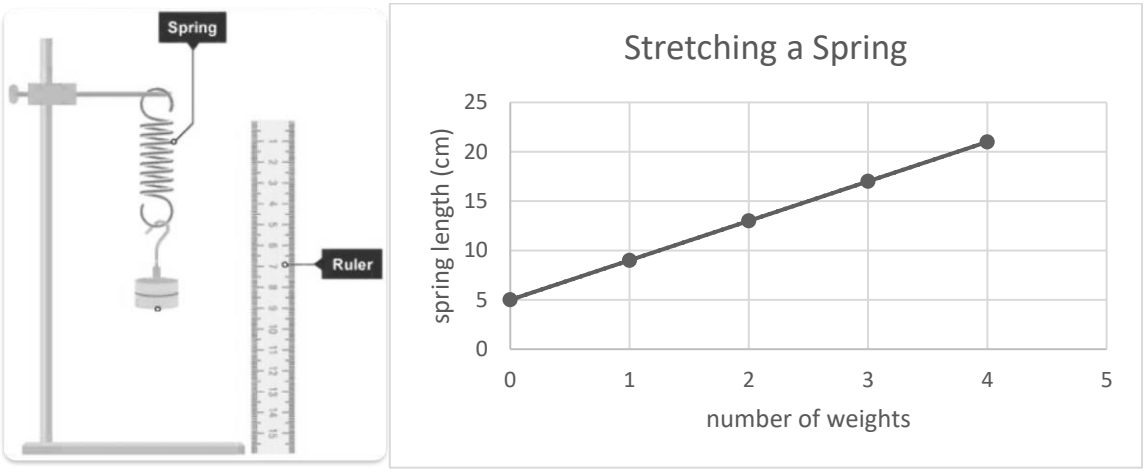

Figure 2: Experimental set-up and the graphed results.

a) Name the **two (2)** variables in this experiment. /1

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b) Why has W (the number of weights) been chosen as the independent variable (and hence graphed as the horizontal axis)? /1

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c) The slope is 4 cm per weight. Interpret the meaning of this value. /2

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d) The y-intercept is 5 cm. Explain the significance of this value. /1

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Questions 2 continues

Marker use

e) The student uses the equation to determine that the spring length would be 4.05 metres (405 cm) if 100 weights were used.

i. How reliable is this prediction? Explain.

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ii. Given your answer in e) i. above, is the equation at all reliable? Explain.

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/2

Total Q2

/9

Question 3 (approximately 7 minutes)

Marker use

Below are general questions about the models used to study sequences and series.

a) i. Growth of organisms in a petri dish follows this sequence: 100, 150, 225, …
Find an equation to model the sequence. /2

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ii. A herd of 1 500 wildebeest grows by 15% each year, but each year 40 wildebeest are lost to lion attacks. Find an equation to model the situation. /2

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b) The rule for the sequence: 5, 9, 13, 17 … , is $T_n = 5 + (n-1)\,4$
Using algebra to simplify, it becomes $T_n = 4n + 1$. To find a particular term (e.g. T_{10}), which equation would give the correct answer? /1

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c) The price of a calculator is initially $100. Inflation is 2.3% p.a.

i. What common ratio would be used to find the sequence of expected prices over the next 5 years? /1

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ii. How many times would the ratio need to be applied to progress from T_2 to T_5? /1

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Total Q3 /7

Question 4 (approximately 4 minutes)

Marker use

Below are general questions about series (summing the terms of a sequence).

a) $100 is invested in a fund paying 10% p.a. compounding annually. The resulting sequence is, 100, 110, 121, 133.1, …

/2

Is a summing formula such as $S_n = \frac{a(1-r^n)}{1-r}$ necessary to find the total in the fund after say 10 years? Explain.

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b) Two friends are discussing this series: 100 + 50 + 25 + 12.5 + …

/2

Friend A comments: "If you keep adding the terms on and on forever your answer will be infinity because you are adding an infinite amount of numbers."

Friend B says: "There will be a limit above which you can never go, no matter how many numbers you add."

Which friend do you agree with? Use a formula to support your answer.

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Total Q4

/4

Question 5 (approximately 7 minutes)

Marker use

Below are general questions about models and concepts involved with the finance topic.

a) For the financial scenarios described in i, ii and iii below, choose the most appropriate financial model from Table 1.

i. A person is repaying a loan in fortnightly instalments. The loan is subject to interest compounding monthly. /1

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ii. The book value of a farm machine decreases by 15% of the cost price each year. /1

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iii. The interest on a credit card is calculated daily. The interest from each day affects the calculation of interest for the next day. /1

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A	Simple interest
B	Compound interest
C	Straight line depreciation
D	Unit cost depreciation
E	Reducing value depreciation
F	Effective interest
G	Annuities in advance
H	Present value of annuity
I	Annuities in arrears
J	Perpetuities

Table 1: Financial models

b) 6% p.a. compounding monthly is equivalent to an effective rate of 6.17% p.a. Explain. /2

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Question 5 continues

Marker use

c) Jackie has purchased an antique watch as an investment. It is growing in value at 2.5% each year. Inflation is expected to average 3% p.a. over the period she owns the watch. Explain whether or not this is a good investment.

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Total Q5

/7

Question 6 (approximately 6 minutes)

Marker use

Below are general questions about annuities.

a) Annuity in Advance means the 'regular payments' happen before the 'lump sum' of money is delivered or achieved. Explain how a savings account might fall into this category. /2

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b) Annuity in Arrears means the 'lump sum' of money is delivered before the regular payments happen. Explain how a housing loan might fall into this category. /2

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c) Alex is trying to calculate how much they will still owe on their home loan after 5 years. They repay $900 each month, interest is 7% p.a. compounding monthly and the loan is calculated to last a total of 20 years. Below is their calculation. What (common) error have they made? /2

$$P = \frac{900[1 - \left(1 + \frac{0.07}{12}\right)^{-5\times12}]}{\frac{0.07}{12}}$$

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Total Q6 /6

End of Section A

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External Assessment 2024

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GENERAL MATHEMATICS

MTG315123

Section B Bivariate Data Analysis

Pages: 16
Questions: 6
Information Sheet: 1

Suggested working time: 36 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 this 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**.
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- All answers must be written in **English**.
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Marker use	
C5	/ 36

Guide to Exam Structure

	Parts	Questions available	Questions to answer	Suggested working time	Marks available
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Section D		6	6	36 minutes	36 marks
Section E	Part 1 **OR**	6	6	36 minutes	36 marks
	Part 2	6	6	36 minutes	36 marks
Totals		**36**	**30**	**180 minutes (3 hours)**	**180 marks**

Criterion

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

- Criterion 5 interpret concepts and apply mathematical techniques to solve problems involving bivariate data analysis and time series analysis using the statistical investigation process.

Question 7 (approximately 5 minutes)

Marker use

Table 2 shows the results from two Australian territories in a national vote. The reason for the vote is irrelevant here.

	ACT	NT	Total
Yes	176 000	43 000	219 000
No	111 000	65 000	176 000
Total	287 000	108 000	395 000

Table 2

a) Complete the percentage table below.

/1

	ACT (%)	NT (%)
Yes		
No		
Total	100	100

Table 3

b) Complete a bar chart below to represent your percentages.

/2

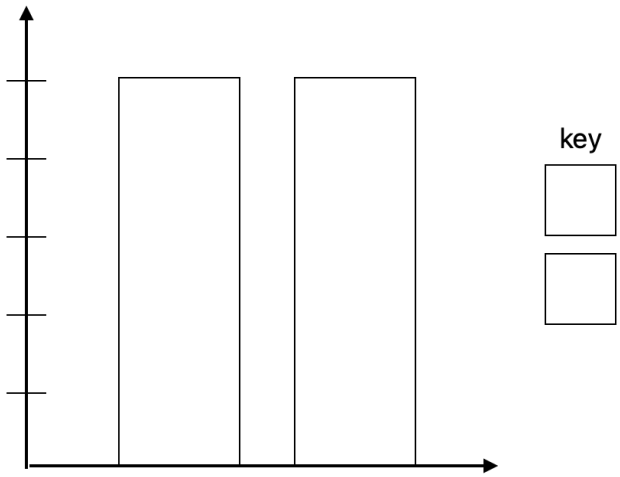

Figure 3: Bar chart to sketch your answer to Question 7 b).

Spare diagram used (X) ☐

Question 7 continues

Question 7 continued

Marker use

c) What is meant by the following statement: “there appears to be some association between these two variables”?

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Total Q7

/5

Question 8 (approximately 3 minutes)

Marker use

Table 4 shows rainfall data recorded by a homeowner on Tasmania's east coast during 2023.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	3	54	19	45	26	46	17	4	20	62	22	29
3-point moving average		25	39	30	39	30	22	14	29			

Table 4

a) Complete the '3-point moving average' row of Table 4. There are **two (2)** values missing.

/1

b) Add your values from Part a) to the graph in Figure 4, to complete it.

/1

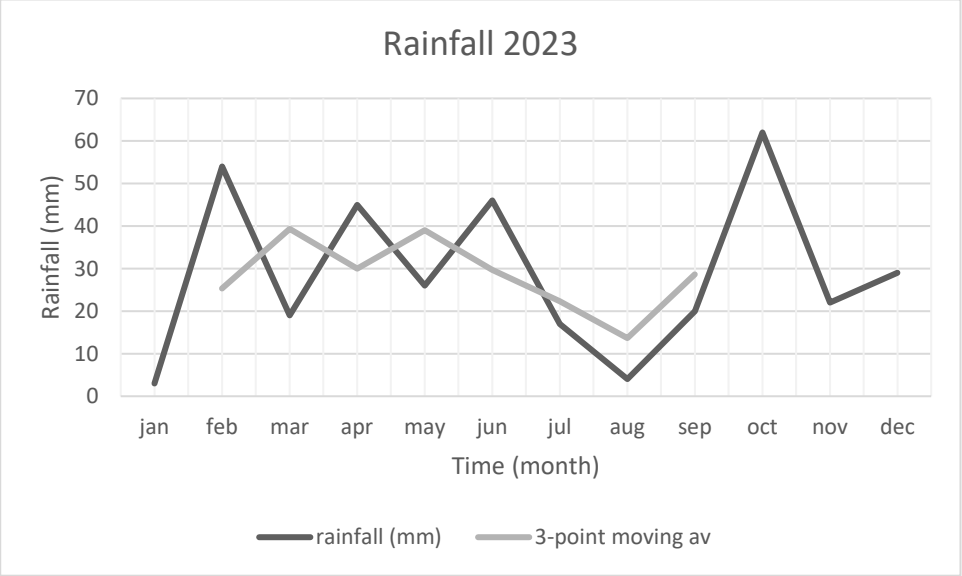

Figure 4: Graph showing rainfall 2023.

Spare diagram used (X) ☐

c) The equation of the 'line of best fit' for the smoothed data is $R = 0.006M + 30.1$, where $R =$ '3-point moving average' of rainfall, and $M =$ the number of months since December 2022.

Two points on this line are (2, 30.1), (11, 30.2). Add these points to the graph in Figure 4 and draw in the line.

/1

Total Q8

/3

Question 9 (approximately 9 minutes)

Marker use

Table 5 shows a measure of blood pressure for a random selection of people of different ages.

Age (years)	17	20	25	29	34	39	42	46
Blood Pressure (mmHg)	114	116	125	130	110	120	124	142

Table 5

a) Assuming 'Age' to be the independent (x) variable, use the regression function on your calculator to find a linear equation representing this data. Use variables A (age) and B (blood pressure). Use **three (3)** decimal places in your equation. /2

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b) Find r and r^2 to **four (4)** decimal places and interpret the correlation coefficient (r). /3

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c) Use your equation from Part a) to predict the blood pressure of a 22 year old. /1

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Question 9 continues

Marker use

d) The (correct) equation predicts that a 60 year old will have blood pressure of 138 mmHg. Discuss the reliability of this prediction, and your prediction in Part c).

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Total Q9

/9

Question 10 (approximately 6 minutes)

Marker use

Table 6 shows the women's Olympic 400m freestyle winning time (in seconds) from 1924 to 1960. The table has columns added to allow calculations of values for a regression formula. (Note: there were no Olympic Games in 1940 or 1944, but this does not affect the calculation.)

	Year (x)	Time (y)	xy	x^2
1924	1	362	362	1
1928	2	343		4
1932	3	329	987	9
1936	4	326	1304	16
1948	7	324	2268	49
1952	8	312	2496	64
1956	9	295	2655	81
1960	10	290	2900	100
Totals (Σ)	44	2581	13658	

Table 6

a) Calculate the **two (2)** missing values, and complete the table above.

/1

b) Use the regression formula from your Information Sheet, using n=8, to calculate values for a and b (the slope and y-intercept of the regression line). Give values to **two (2)** decimal places.

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Question 10 continues

Marker use

c) Write the regression equation using variables Y (year) and T (time).

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d) Predict the women's Olympic 400m freestyle winning time for 1968.

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Total Q10

/6

Question 11 (approximately 6 minutes)

Marker use

Table 7 and Figure 5 show the population of India from the year 1950 to 2000. A 'residual' column is included in Table 7. A regression line is included in the first graph in Figure 5. The second graph is of Residual values.

Year	Population (million)	Residual (million)
1950	357	44.19
1960	446	-7.55
1970	558	-36.30
1980	697	-38.04
1990	870	
2000	1060	

Table 7

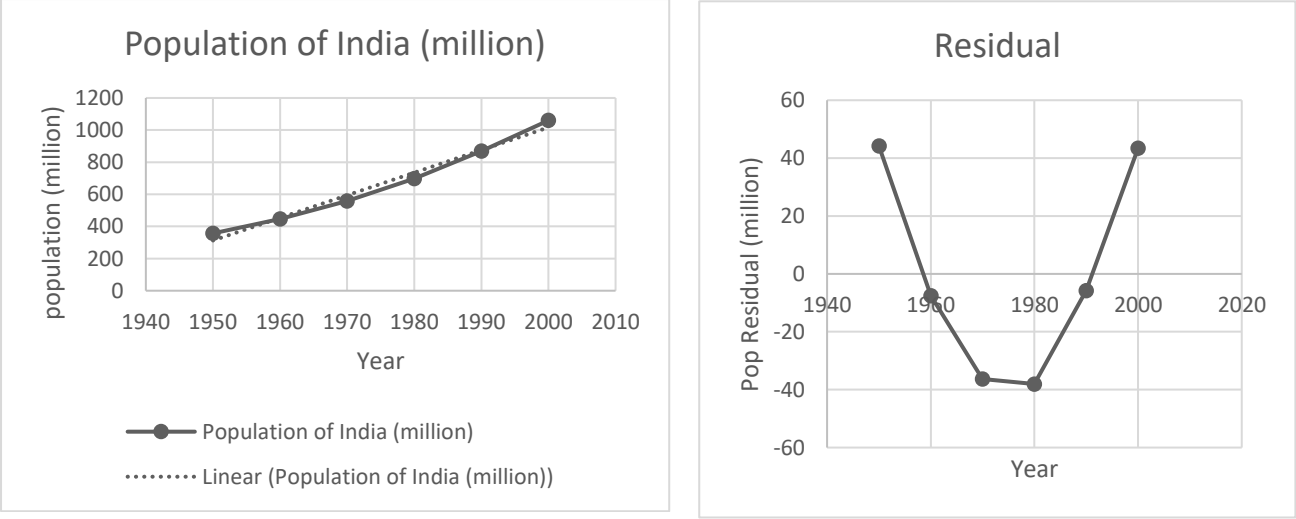

Figure 5: Graphs showing population of India (million) and residual values.

a) Use your calculator to complete the Residuals column of Table 7. Give answers to **two (2)** decimal places. /2

b) Interpret the residual point (1970, -36.30). /2

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Question 11 continues

Marker use

c) Is the linear model an appropriate choice? Explain.

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Total Q11

/6

Question 12 (approximately 7 minutes)

Marker use

Table 8 shows quarterly power costs for a Tasmanian household. The process of deseasonalising the data has almost been completed.

Power Costs ($) for Tasmanian Household

	Summer	Autumn	Winter	Spring	Average
2021	390	530	660	495	519
2022	380	503	690	490	
2023	360	540	730	510	535

2021	0.751	1.021	1.272	0.954
2022	0.736	0.975	1.337	0.950
2023	0.673		1.364	0.953
Index	**0.720**	**1.002**		**0.952**

Deseasonalised Data

2021	542	529	498	
2022	528	502	521	515
2023	500	539	551	536

Table 8

a) Find and complete the **four (4)** numbers missing from the table above.

/2

b) Which season of which year has the highest deseasonalised value? Explain the significance of this.

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Question 12 continues

Marker use

/3

c) Figure 6 is a graph of the actual and the deseasonalised data, and a regression line for the deseasonalised data. The equation of the regression line for the deseasonalised data is, $D = 1.0459x + 516.33$ where x is the season number. Predict the **actual** power cost for Spring of 2024.

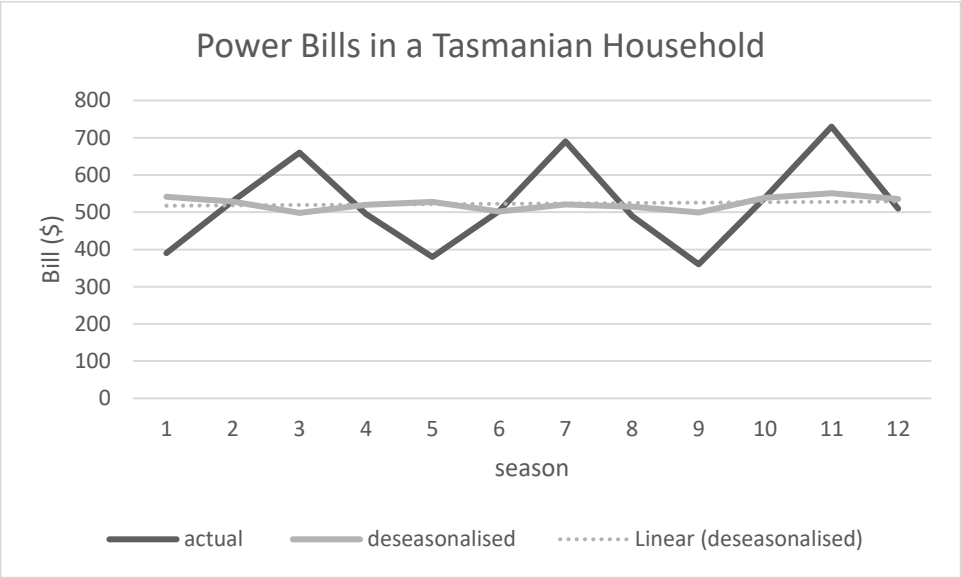

Figure 6: Graph showing original and deseasonalised data.

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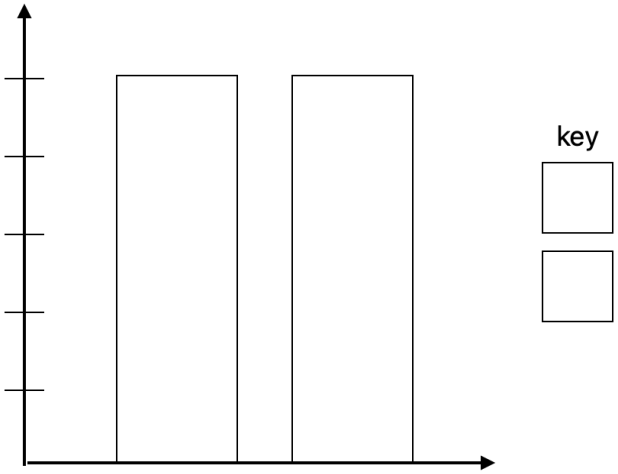
Total Q12

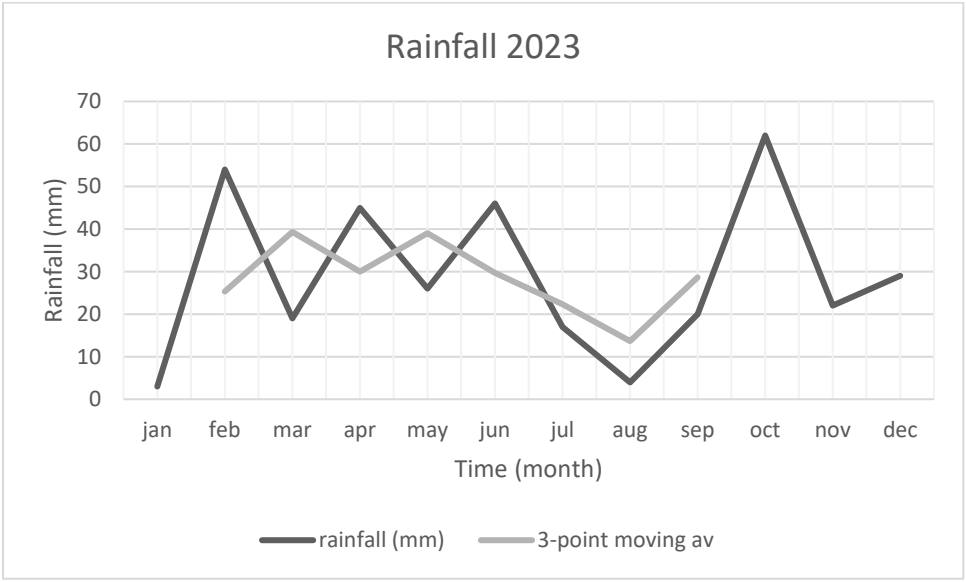
/7

Spare Diagrams

Question 7 b)



Question 8 b) and c)



End of Section B

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GENERAL MATHEMATICS

MTG315123

Section C Growth and Decay in Sequences

Pages: 12

Questions: 6

Information Sheets: 1

Suggested working time: 36 minutes

Instructions:

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Marker use	
C6	/ 36

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Guide to Exam Structure

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Section E	Part 1 **OR**	6	6	36 minutes	36 marks
	Part 2	6	6	36 minutes	36 marks
Totals		**36**	**30**	**180 minutes (3 hours)**	**180 marks**

Criterion

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

- Criterion 6 interpret concepts and apply mathematical techniques to model patterns and solve problems involving growth and decay in sequences.

Question 13 (approximately 5 minutes)

Marker use

A conservationist has bought 200 hectares of land in central Tasmania that is covered in gorse, a hardy, prickly weed. They expect to be able to clear 12 hectares per year.

a) Given that the first term is 200, find the next **three (3)** terms in the sequence representing the amount of uncleared land at the beginning of each year. /1

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b) Is this sequence arithmetic or geometric? /1

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c) Find the (explicit) rule for the sequence. /2

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d) Use the rule to find the 15^{th} term (the amount of uncleared land at the beginning of the 15^{th} year). /1

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Total Q13 /5

Question 14 (approximately 8 minutes)

Marker use

Table 9 shows the declining number of births per year in a large country.

2021	2022	2023
15 644 946 (T_1)	15 269 467 (T_2)	14 903 000 (T_3)

Table 9

a) Is the sequence arithmetic or geometric? Show working out.

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/2

b) Find the (explicit) rule for this sequence.

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/2

c) Use a formula to predict the total number of births over the 10 years from 2021 (including 2021). Give a final answer correct to the nearest whole number.

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d) By continually adding the number of births in this sequence, on and on forever, what is the answer?

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Total Q14

/8

Question 15 (approximately 4 minutes)

Marker use

Following are two sequence rules in explicit form. Find the recursive form (difference equation) of each rule.

a) $T_n = 12 + (n-1)\,16$

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/2

b) $T_n = 0.5 \times (-3)^{n-1}$

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/2

Total Q15

/4

Question 16 (approximately 3 minutes)

Marker use

Table 10 shows Tasmania's population in 2015 and 2022.

Year	Population
2015	515 000 (T_1)
2022	572 000 (T_8)

Table 10

Assuming that our population, year by year, follows an arithmetic sequence, find the (explicit) rule for the sequence. Give values in your final answer with **one (1)** decimal place.

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Total Q16

/3

Question 17 (approximately 7 minutes)

Marker use

The (explicit) rule for an arithmetic sequence is $T_n = 22 - 6n$

a) The number $-\mathbf{260}$ is a term of this sequence. Determine which term this is.

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b) If the first term is 16, find the sum of the first 47 terms.

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c) How many terms of this sequence must be added to achieve a total of $-\mathbf{110}$?

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Total Q17

/7

Question 18 (approximately 9 minutes)

Marker use

A mining town with a population of 5 000, is declining at the rate of 15% per year as mine workers depart. Simultaneously, the introduction of tourism, including mountain bike trails in the surrounding hills, has caused an increase of 600 people per year.

a) Find a difference equation to represent the town's population, year by year.

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/2

b) What happens to the town's population in the long term?

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/2

The town council wants to help redundant workers from the mine industry to find jobs in tourism and stay. The rate of decline decreases to 10%. Assume other variables remain unchanged.

c) Find a new difference equation to represent the town's population, year by year.

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d) Now what happens to the town's population in the long term?

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e) What rate of decline should the council aim for if they want to maintain a steady population of 5 000?

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Total Q18

/9

End of Section C

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& CERTIFICATION

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GENERAL MATHEMATICS

MTG315123

Section D Finance

Pages: 12
Questions: 6
Information Sheet: 1

Suggested working time: 36 minutes

Instructions:

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Marker use	
C7	/ 36

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	Part 2	6	6	36 minutes	36 marks
Totals		**36**	**30**	**180 minutes (3 hours)**	**180 marks**

Criterion

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

- Criterion 7 interpret concepts and apply mathematical techniques to solve problems involving standard financial models.

Question 19 (approximately 9 minutes)

Marker use

A business owner predicts that in 3 years' time the business will have grown so much they will need to purchase a forklift (lifting machine).

a) If the required new machine costs $65 000 now, how much will it cost in 3 years, if inflation is expected to average 2.3% p.a.? /2

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b) The business owner investigates some saving options. Complete Table 11 and decide which interest arrangement would accumulate the most interest. Give answers to **three (3)** decimal places. /2

Interest Offered	Effective Rate (% p.a.)	Which gives most interest (tick ✓)
3.1% p.a. compounding daily		
3.2% p.a. compounding weekly		
3.3% p.a. compounding fortnightly		

Table 11

c) The owner decides to use the finance company offering 3.3% p.a. compounding fortnightly.

i. How many interest periods are there each year? /1

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ii. How many interest periods are there in total over 3 years? /1

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iii. How much will need to be invested in the account initially to have $70 000 in 3 years' time? /3

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Total Q19 /9

Question 20 (approximately 4 minutes)

Marker use

Casey has been working hard. They find a holiday package deal for 1 week in Bali and pay $2 500 using their credit card. Purchases on the credit card are interest free until the date the first payment is due. If a payment is missed there is a $25.00 fee. Interest is 20.99% p.a. compounding daily.

a) How much will Casey pay if they pay the total owing before the due date?

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/1

b) How much will Casey pay, in total, if they neglect to make the first **three (3)** payment dates? They pay interest for 70 days when they finally pay.

/3

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Total Q20

/4

Question 21 (approximately 8 minutes)

Marker use

The owner of a small business buys a ute (small truck) for $45 000. The vehicle is expected to last for 320 000km and has an expected 'scrap value' of $800.

a) Using the Unit Cost Depreciation method:

i. Find R, the depreciation per km, correct to **three (3)** decimal places.

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ii. Find the Book Value after 100 000km.

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Figure 7 shows the Book Value of the $45 000 ute using two different depreciation methods. For Straight Line depreciation, the equation is $V = -3214n + 45\,000$. For Reducing Balance depreciation, the equation is $V = 45000(1 - 0.12)^n$.

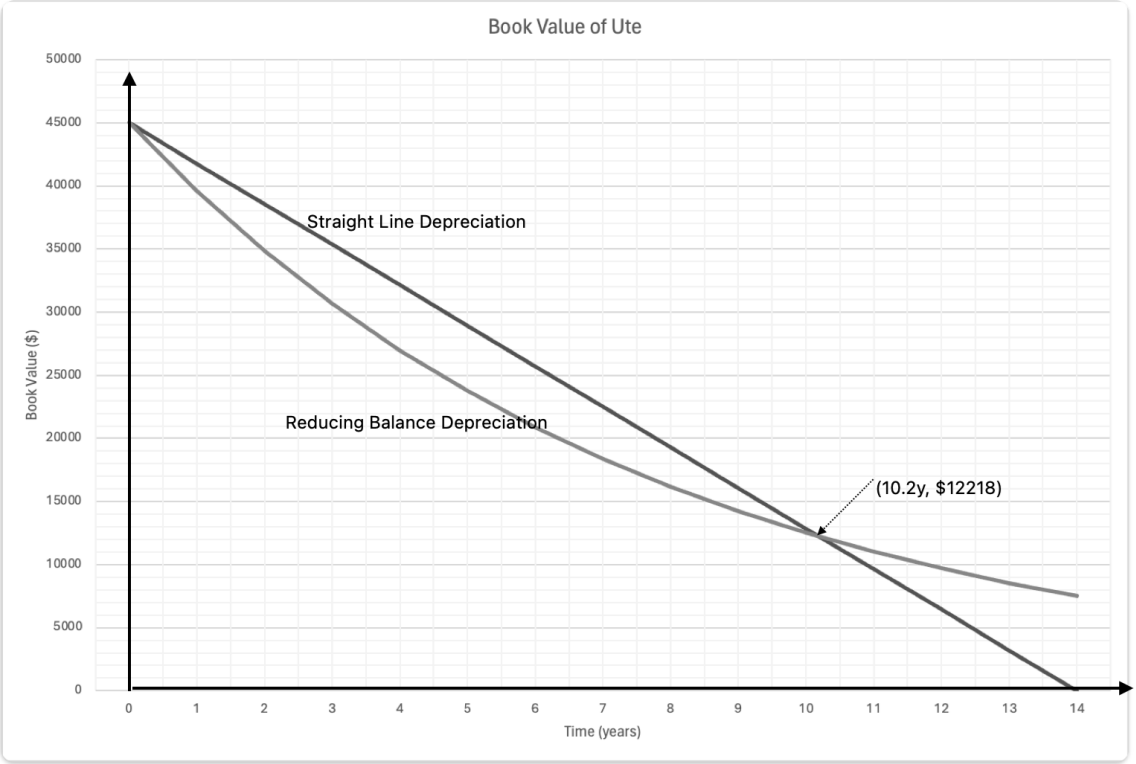

Figure 7: Graph showing Book Value.

Question 21 continues

Marker use

b) Use the graph in Figure 7 to estimate the Book Value of the ute after 5 years.

i. Using Straight Line Depreciation. /0.5

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ii. Using Reducing Balance Depreciation. /0.5

.....

c) A tax specialist advises the owner to use the method that will predict more depreciation. **Explain** which method they should use:

i. If they plan to keep the car for 5 years. /1

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ii. If they plan to keep the car for 12 years. /1

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d) If the Straight Line method involved a reduction in value of $4 000 (instead of $3 214) each year, and all other values were unchanged, determine how many years before the two methods predict the same value (other than initially). Give your answer in years to **two (2)** decimal places. /3

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Total Q21 /8

Question 22 (approximately 8 minutes)

Marker use

Imagine, in your future working life, that you want to save $6 000 over 2 years. Your savings account pays 3% p.a. compounding monthly.

a) Use a formula and algebra to find how much you would have to deposit each month.

/3

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b) Calculate the 'Present Value' of your future savings ($6 000).

/2

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Question 22 continues

Marker use

/3

c) Use an Interest Factor from Table 12, to confirm your answer to Part a).

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

	int per period i =	0.00083	0.00167	0.00250	0.00333	0.00417	0.00500	0.00583	0.00667
number of periods	1	1.0008	1.0017	1.0025	1.0033	1.0042	1.0050	1.0058	1.0067
	2	2.0025	2.0050	2.0075	2.0100	2.0125	2.0150	2.0175	2.0200
	3	3.0050	3.0100	3.0150	3.0200	3.0251	3.0301	3.0351	3.0402
	4	4.0083	4.0167	4.0251	4.0334	4.0418	4.0503	4.0587	4.0671
	5	5.0125	5.0251	5.0376	5.0502	5.0628	5.0755	5.0882	5.1009
	6	6.0175	6.0351	6.0527	6.0704	6.0881	6.1059	6.1237	6.1416
	7	7.0234	7.0468	7.0704	7.0940	7.1176	7.1414	7.1653	7.1892
	8	8.0301	8.0602	8.0905	8.1209	8.1515	8.1821	8.2129	8.2438
	9	9.0376	9.0753	9.1133	9.1513	9.1896	9.2280	9.2666	9.3054
	10	10.0459	10.0921	10.1385	10.1852	10.2321	10.2792	10.3265	10.3741
	11	11.0552	11.1106	11.1664	11.2225	11.2789	11.3356	11.3926	11.4499
	12	12.0652	12.1308	12.1968	12.2632	12.3300	12.3972	12.4649	12.5329
	24	24.2516	24.5064	24.7646	25.0260	25.2909	25.5591	25.8308	26.1061
	36	36.5604	37.1319	37.7146	38.3088	38.9148	39.5328	40.1630	40.8058
	48	48.9929	50.0122	51.0585	52.1328	53.2358	54.3683	55.5313	56.7256
	60	61.5503	63.1524	64.8083	66.5200	68.2894	70.1189	72.0105	73.9667
	72	74.2338	76.5579	78.9763	81.4933	84.1133	86.8409	89.6810	92.6388
	84	87.0448	90.2340	93.5753	97.0767	100.7467	104.5943	108.6290	112.8607
	96	99.9844	104.186	108.618	113.295	118.231	123.443	128.947	134.761
	108	113.054	118.420	124.119	130.174	136.610	143.454	150.733	158.479
	120	126.255	132.941	140.091	147.741	155.929	164.699	174.094	184.166
	240	265.782	295.288	329.123	367.997	412.746	464.351	523.965	592.947
	360	419.978	493.547	584.194	696.362	835.725	1009.54	1227.09	1500.30

Table 12

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Total Q22

/8

Question 23 (approximately 3 minutes)

Marker use

/3

A recent retiree, aged 65, has accumulated $600 000 in a superannuation fund over their working life. The fund averages interest of 9% p.a. compounding monthly. They work out that they will need a monthly payment of $4 800 from this fund. How long will the superannuation fund last?

Give your answer in years and months.

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Total Q23

/3

Question 24 (approximately 4 minutes)

Marker use

A couple has borrowed $400 000 to purchase a house. Their bank charges 6.3% p.a. interest compounding monthly. The couple plans to make monthly payments of $2 470.

a) Write a difference equation to represent this. Your 'r' value should either include a fraction, or have at least **six (6)** decimal places.

/2

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b) Use your difference equation to determine how long it will take to pay back the loan. Give your answer in months, and comment on the final payment.

/2

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End of Section D

Total Q24

/4

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GENERAL MATHEMATICS

MTG315123

Section E Networks **or** Trigonometry

Pages: 28

Questions: 12

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 16.
- Write your answers in the spaces provided in this exam paper.
  - Spare diagrams have been provided at the end of each part. 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 the exam.
- All answers must be written in **English**.
- You **must** make sure your answers address the listed criterion.

Marker use	
C8	/ 36

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Guide to Exam Structure

	Parts	Questions available	Questions to answer	Suggested working time	Marks available
Section A		6	6	36 minutes	36 marks
Section B		6	6	36 minutes	36 marks
Section C		6	6	36 minutes	36 marks
Section D		6	6	36 minutes	36 marks
Section E	Part 1 **OR**	6	6	36 minutes	36 marks
	Part 2	6	6	36 minutes	36 marks
Totals		**36**	**30**	**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 25 (approximately 5 minutes)

Figure 8 is a diagram representing footpaths at a wildlife sanctuary. Distances are shown in metres.

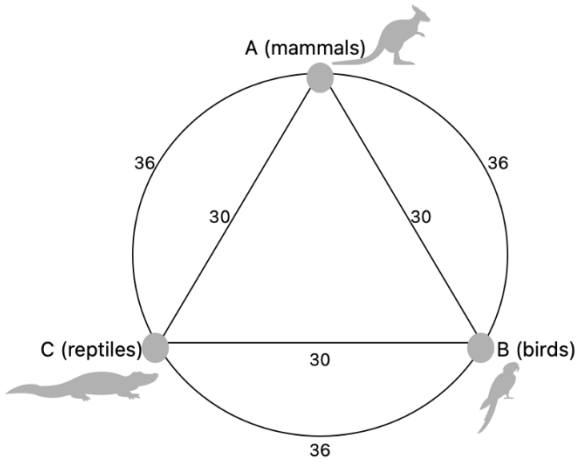

Figure 8: Diagram representing footpaths at a wildlife sanctuary.

a) Find a trail starting at A (the mammals) that uses all of the footpaths once and returns to A. Write your answer as a sequence of letters. /2

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b) What is the term given to this kind of trail? /1

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c) How can you tell that such a trail is possible, before actually finding it? /1

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d) Find the length of the shortest closed Hamiltonian Path, starting and finishing at C (the reptiles). /1

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Total Q25 /5

Question 26 (approximately 4 minutes)

Marker use

Table 13 represents tasks in a renovation project.

Task	Task Symbol	Immediate Predecessor
Fix foundations	A	-
Fix electrical	B	A
Renovate kitchen	C	A
Renovate bathroom	D	B
Paint	E	C, D

Table 13

a) What must happen before 'Fix electrical'?

.....

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/1

b) Which task cannot happen until both 'Renovate kitchen' and 'Renovate bathroom' are complete?

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/1

c) Draw the precedence graph represented by Table 13. Each task will be represented by an arrow.

/2

Total Q26

/4

Question 27 (approximately 8 minutes)

Marker use

The following questions are about the process of Critical Path Analysis.

a) Figure 9 is part of a precedence graph for a project. Fill in the top part of each of the the 'time-keeper' boxes by completing a 'forward scan'.

/2

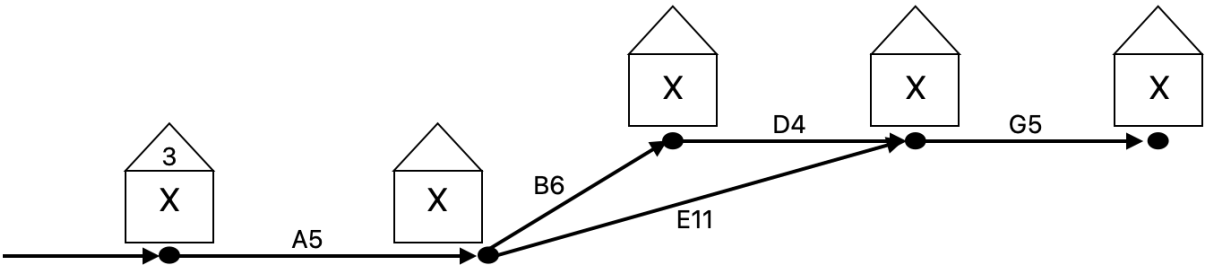

Figure 9: Precedence graph for Question 27 a).

Spare diagram used (X) ☐

b) Figure 10 is part of a precedence graph for a different project. Fill in the lower part of the 'time-keeper' boxes by completing a 'backwards scan'.

/2

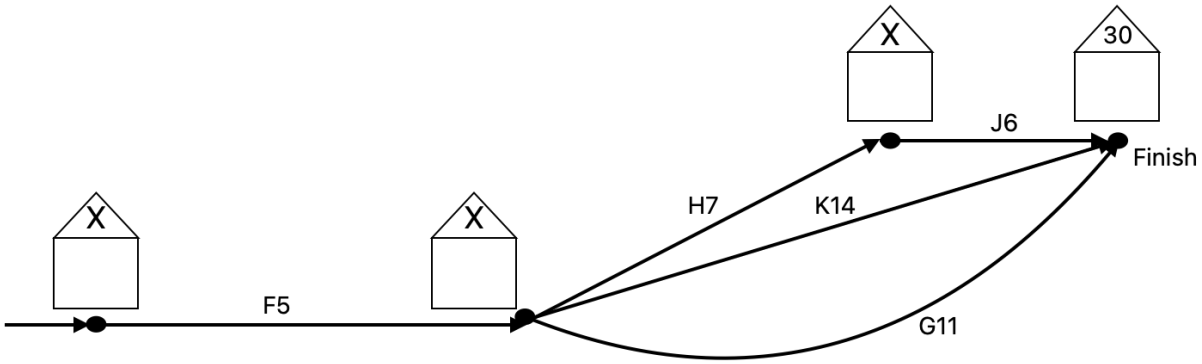

Figure 10: Precedence graph for Question 27 b).

Spare diagram used (X) ☐

Question 27 continues

Question 27 continued

Marker use

Figure 11 is a precedence graph for the construction of a large shed. The times shown are in weeks.

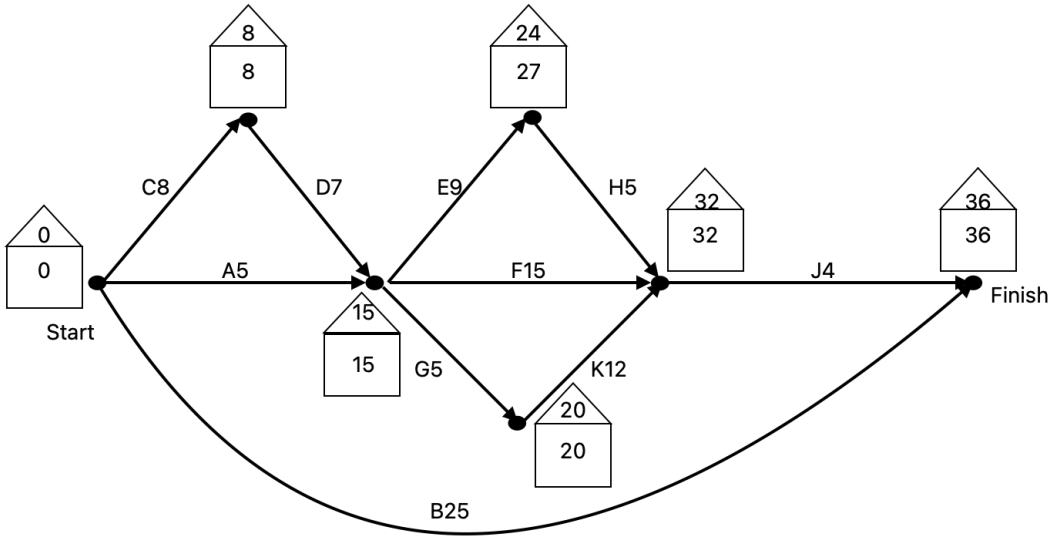

Figure 11: Precedence graph for the construction of a large shed.

c) Write the Critical Path as a sequence of letters.

..... /1

d) Calculate the float for task G, and use it to determine how the project completion time will be affected if this task requires four weeks more than expected:

i. Float for task G.

..... /0.5

ii. New project completion time.

..... /0.5

e) Calculate the float for task E, and use it to determine how the project Critical Path and completion time will be affected if this task requires four weeks more than expected.

i. Float for task E: ..... /0.5

ii. New project completion time: ..... /0.5

iii. Critical path: ..... /1

.....

Total Q27 /8

Question 28 (approximately 10 minutes)

Marker use

Figure 12 shows a system of water pipes through a Marine Research Laboratory. The numbers on the pipes represent the capacity (the maximum amount of water the pipe can carry) in litres per minute. Some, but not all 'cuts', have been drawn on the diagram.

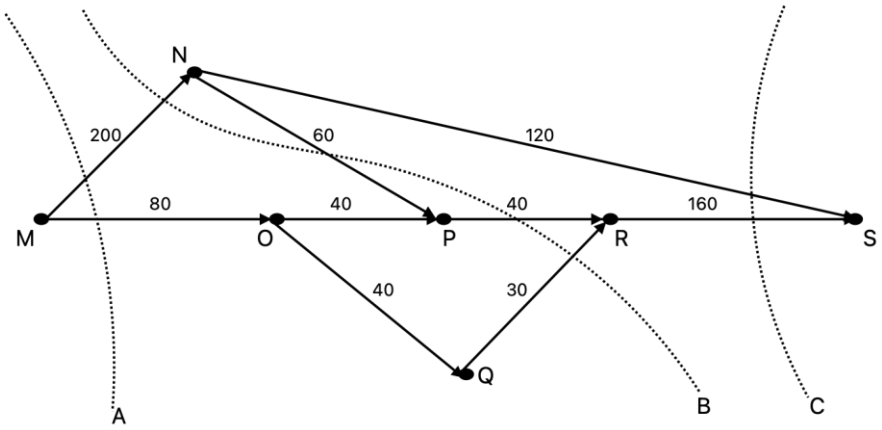

Figure 12: System of water pipes through a Marine Research Laboratory.

Spare diagram used (X) ☐

a)

i. Label the source and sink on the diagram in Figure 12. /1

ii. Add another (new) cut to the diagram in Figure 12. /1

iii. What is the capacity of cut A?

..... /1

iv. What is the capacity of cut B?

..... /2

Question 28 continues

Marker use

b) The cuts required for the following analysis have been drawn for you.

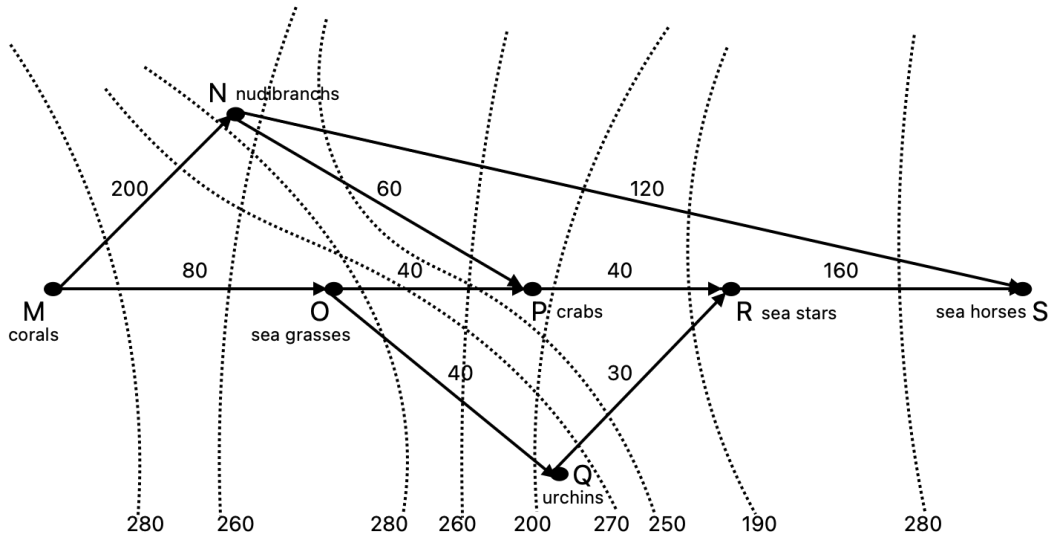

Figure 13: System of water pipes through a Marine Research Laboratory.

i. What is the maximum water flow through this system?

..... /1

ii. Which **three (3)** pipes are possibilities for upgrade to improve the total flow through the system? /1

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iii. The researchers need to improve maximum flow. They are considering upgrading pipe PR. What capacity pipe should PR be? Explain by referring to relevant cuts. /2

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iv. What is the new maximum flow through the system? /1

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Total Q28 /10

Exam continues over the page

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Question 29 (approximately 3 minutes)

Marker use

Four friends plan to enter a wilderness multi-sport event. The event requires teams of four, where one member will complete the road bike leg, one will do the mountain bike leg, one will paddle a kayak and one will run. Table 14 shows the capabilities of the team.

Team Member	**Team Member's Skills**
Peta	road bike, kayak, run
Taylor	road bike, run
Charlie	run
Frankie	mountain bike, kayak

Table 14

a) Draw a bi-partite graph to represent Table 14.

/2

b) Use your bi-partite graph to assign team members to a sport, or leg of the event.

/1

Total Q29

/3

Question 30 (approximately 6 minutes)

Marker use

A class of General Mathematics students has invented some speed skill events so that teams in the class can compete. Shown in Table 15 are the best times, in seconds, for the members of one team.

Team Member	1. Eat bowl of jelly	2. Do 3 head stands	3. Make a paper plane that flies	4. Run around the Maths Block
A	62	40	66	62
B	67	47	61	57
C	62	44	55	57
D	68	45	58	53

Table 15

a) The team is using the Hungarian Algorithm to determine who will do which activity. Complete the final row of the 'row reduction' shown in Table 16. /1

22	0	26	22
20	0	14	10
18	0	11	13

Table 16

b) The 'column reduction' has been completed. The result is in Table 17. Complete Table 18 using the Hungarian Method. /2

4	0	15	14
2	0	3	2
0	0	0	5
5	0	2	0

Table 17

Table 18

Spare diagram used (X) ☐

Question 30 continues

Marker use

c) Table 19 is the final table, after using the Hungarian Method, for a **different team**.

Team Member	1. Eat bowl of jelly	2. Do 3 head stands	3. Make a paper plane that flies	4. Run around the Maths Block
E	3	14	0	12
F	0	0	0	2
G	3	0	6	0
H	0	6	3	3

Table 19

i. How can it be shown that the process is finished?

.....

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.....

/1

ii. Assign each team member to an activity.

Team Member	Activity
E	
F	
G	
H	

Table 20

/2

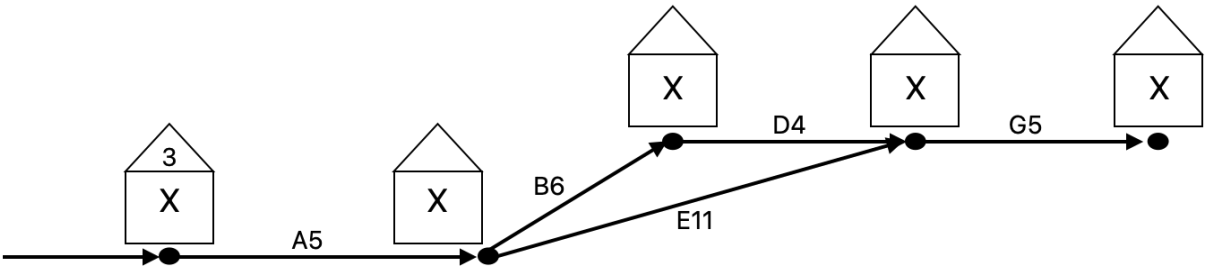
Total Q30

/6

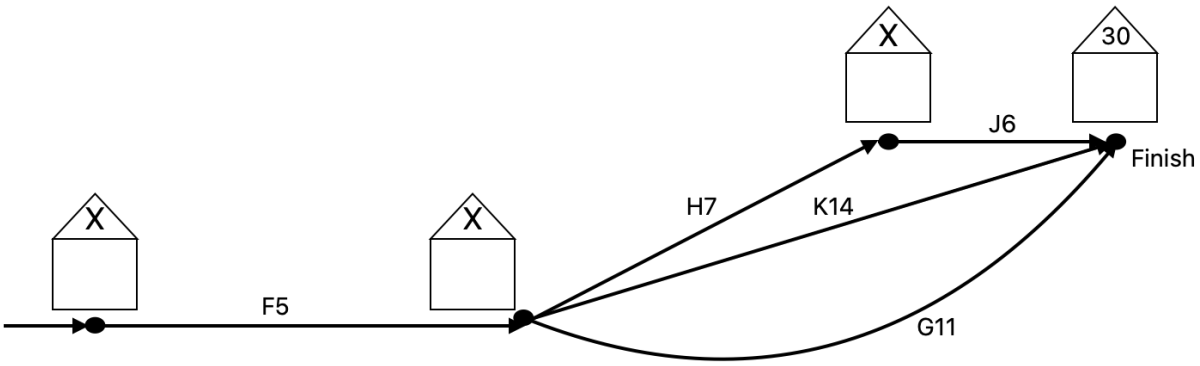
Spare Diagrams

Marker use

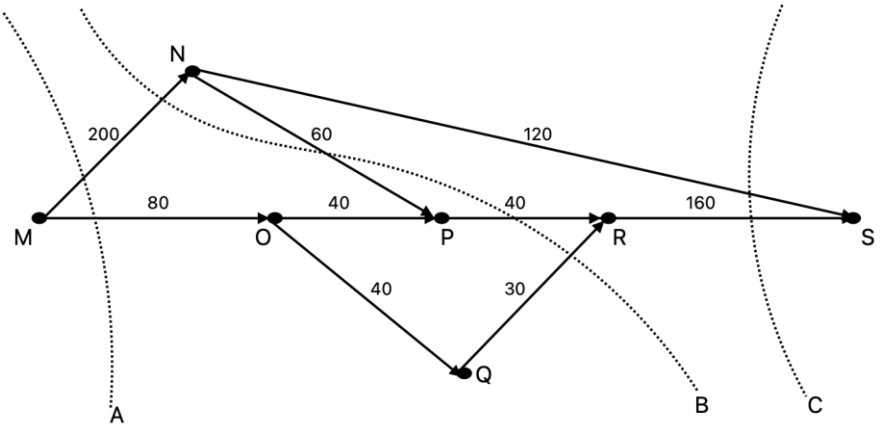
Question 27 a)



Question 27 b)



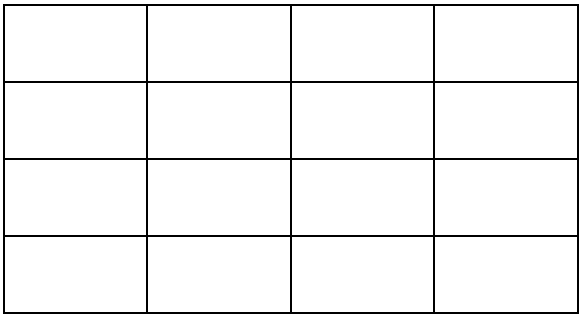
Question 28 a)



Spare Diagrams

Marker use

Question 30 b)



Part 2 – Trigonometry

Marker use

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

Question 31 (approximately 7 minutes)

The diagram in Figure 14 represents a cliff top, a yacht on the water and a bird above.

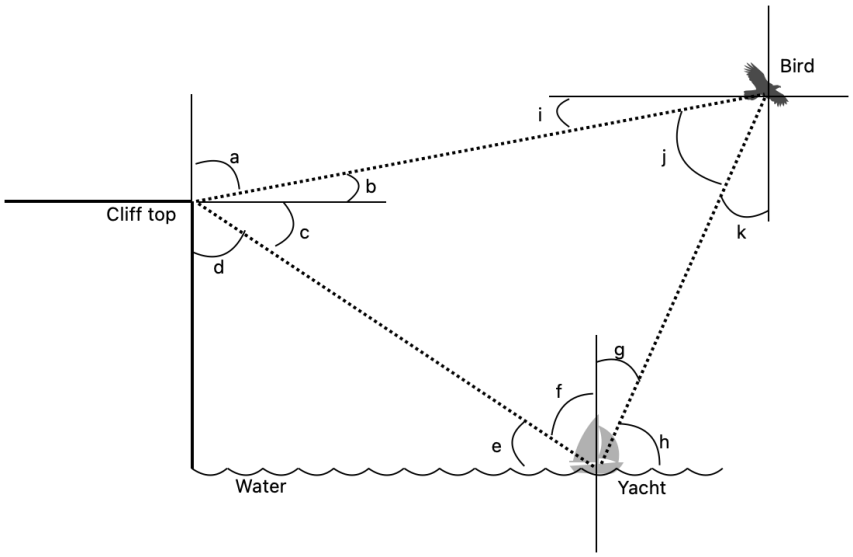


Figure 14: Diagram of a cliff top, a yacht on the water and a bird above.

a) Which letter on the diagram **best** represents:

i. The angle of elevation of the bird from the cliff top?

..... /0.5

ii. The angle of depression of the yacht from the cliff top?

..... /0.5

iii. The angle of elevation of the bird from the yacht?

..... /0.5

iv. The angle of depression of the clifftop from the bird?

..... /0.5

Question 31 continues

Marker use

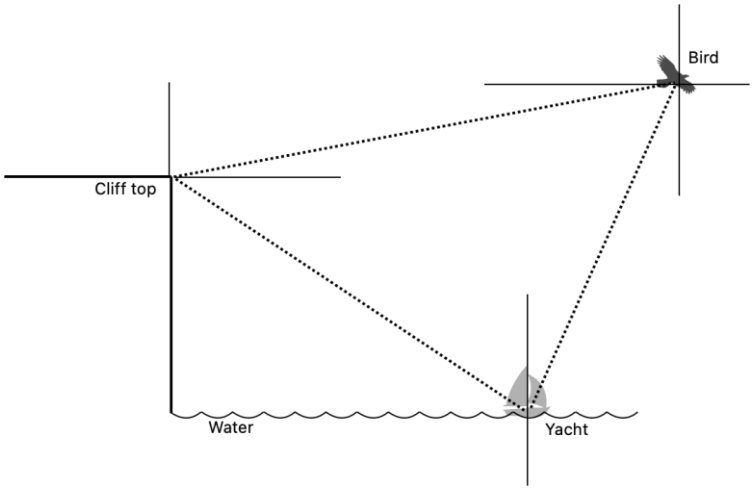


Figure 15: Diagram of a cliff top, a yacht on the water and a bird above.

b) Consider the triangle joining the cliff top, cliff base and the yacht in Figure 15.

i. If the cliff is 300m high, and the boat is 400m from the base of the cliff, use Pythagoras' Theorem to find the straight line distance from the cliff top to the yacht. /1

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ii. Find the angle, e, between the horizontal (water) side and the hypotenuse. Give your answer to **two (2)** decimal places. /2

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c) If the bird is 700m from the cliff top, the yacht is 500m from the cliff top and the angles c and b add to 40º, find the area of the triangle joining the cliff top, yacht and bird. Include units in your answer. /2

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Total Q31 /7

Question 32 (approximately 3 minutes)

Marker use

An archaeologist is trying to determine the location of a burial site (B) from diagrams in ancient documents. In one diagram they note the angle of elevation of the pyramid from a palace ruin (A) is 25º. In another diagram they can see that the angle of elevation of the pyramid from the burial site is 62º, and that the three features are in a straight line. The pyramid has a vertical height of 130m.

In Figure 16 the archaeologist has combined all this information.

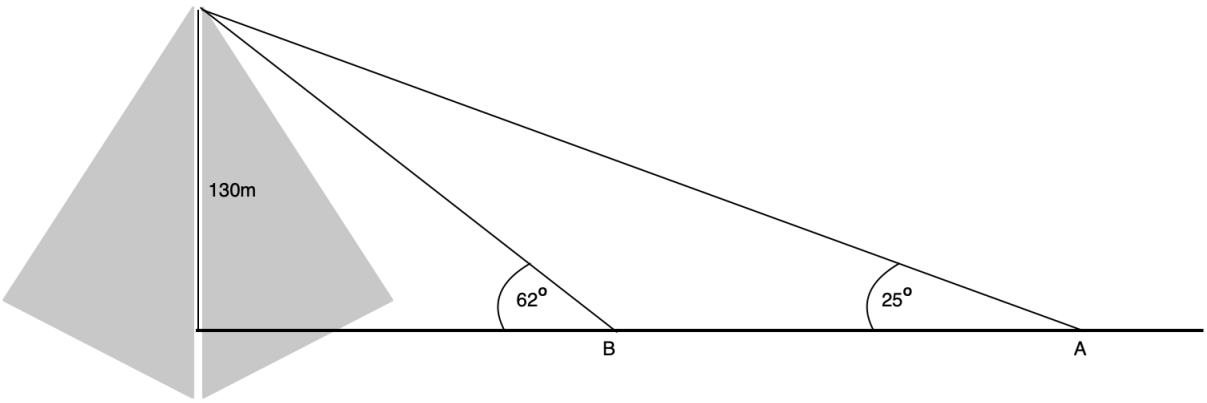

Figure 16: Archaeologist's diagram showing angles of elevation.

How far from the palace ruin should they dig to find the burial site?

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Total Q32

/3

Question 33 (approximately 6 minutes)

Marker use

A large ship (A) has been asked to direct a rescue boat (B) to the location of an overloaded drifting boat at (C), during the night. Figure 17 summarises this situation.

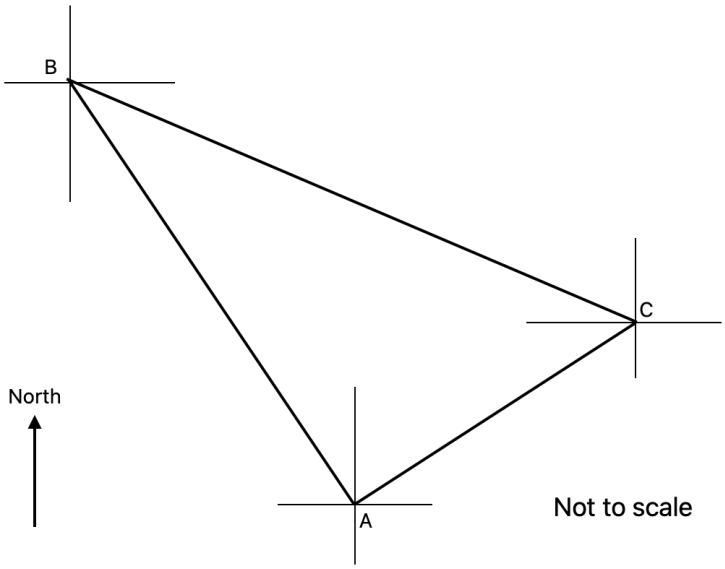

Figure 17: Diagram showing boat locations.

The ship captain advises: “The rescue boat is 16 km from us (A) on a bearing of N14ºW. The drifting boat is 13km from us (A) on a bearing of N42ºE.”

a) Find the distance from the rescue boat (B) to the drifting boat (C). Give your answer to **two (2)** decimal places. /2

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b) Find the bearing of the drifting boat (C) from the rescue boat (B). /4

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Total Q33 /6

Question 34 (approximately 10 minutes)

Marker use

A yacht owner is planning to sail **due north** from East Cape (the Eastern tip of New Zealand) to Fiji, and then due west to Hinchinbrook Island (Queensland).

a) Consider the first leg of this trip.

i. Will travelling due north be the shortest route from East Cape to Fiji? Explain.

/2

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ii. Find the distance they will sail, to the nearest km, using coordinates:
East Cape (38ºS, 178ºE), Fiji (18ºS, 178ºE).

/2

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iii. The GPS coordinates of East Cape, the eastern tip of New Zealand, are (-37.6908, 178.5396). Convert these coordinates to latitude and longitude in degrees and minutes, rounding to the nearest whole minute.

/2

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Question 34 continues

Marker use

b) Consider the second leg of the trip: Due West from Fiji (F) (18ºS, 178ºE) to Hinchinbrook Island (H) (18ºS, 146ºE). See Figure 18.

i. Mark both places, F and H, on the diagram.

/1

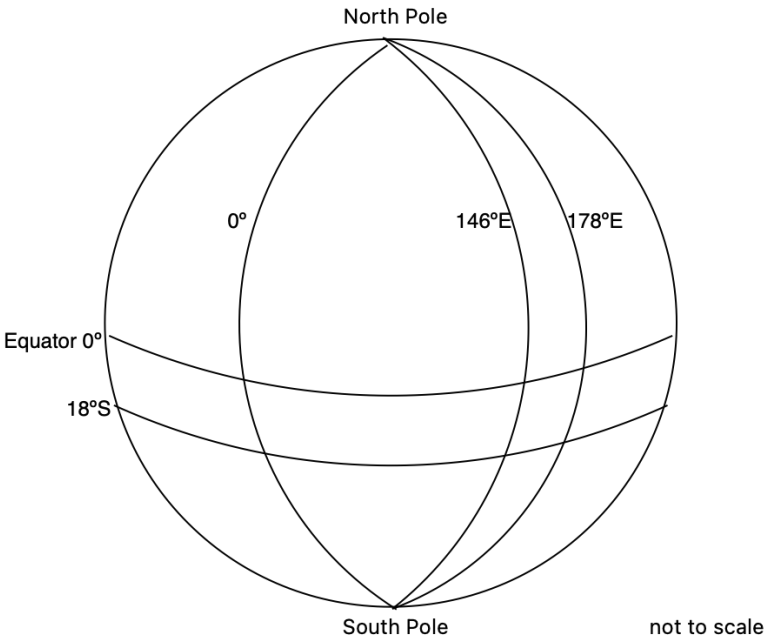

Figure 18: Diagram showing latitude and longitude.

Spare diagram used (X) ☐

ii. Travelling directly west makes compass navigation easier but is not actually the shortest route. Explain why.

/1

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iii. Find the distance they will travel on the second leg.

/2

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Total Q34

/10

Question 35 (approximately 3 minutes)

Marker use

Find the shortest distance between Sydney (34ºS, 151ºE) and Singapore (1ºN, 104 ºE).

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Total Q35

/3

Question 36 (approximately 7 minutes)

Marker use

A plane is to fly from Dubai to Singapore to Perth (Western Australia).

a) Find the time difference between Dubai (25ºN, 55ºE) and Perth (32 ºS, 116 ºE), showing working out and stating which city is ahead. /2

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b) The Airbus 320 is one of the more common aircraft in international travel. It has an average flight speed of 840km/h. Calculate the total flying time on the route (Dubai, Singapore, Perth) if the distance is 9 745km. Answer in hours and minutes correct to the nearest minute. /2

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c) Strong winds extend flight times. The plane departs Dubai and flies for 7 hours and 25 minutes to Singapore. It stops in Singapore for 3 hours then continues for 5 hours and 10 minutes to Perth, Western Australia, arriving at 2 a.m. on the 10th of August. Find the time and date of departure from Dubai. /3

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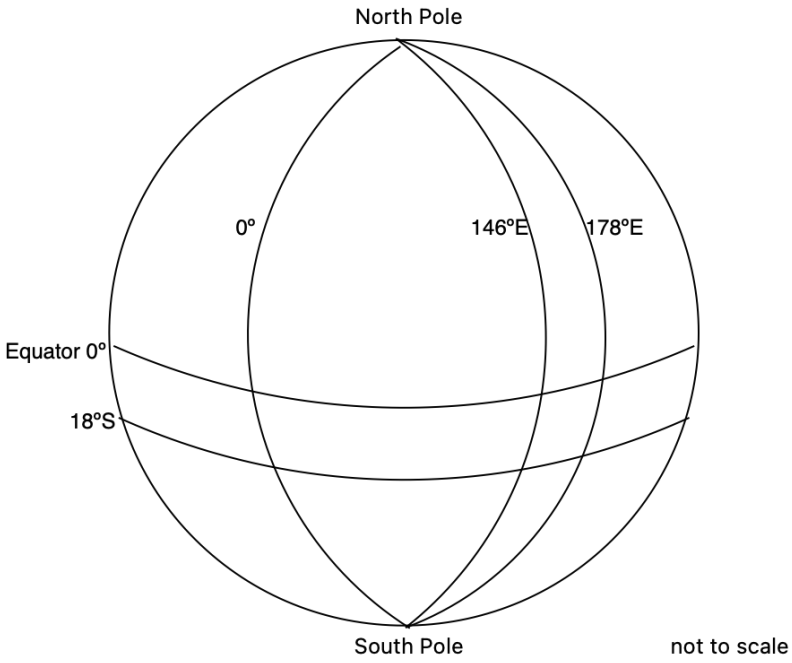
Total Q36 /7

Spare Diagram

Marker use

Question 34 b) i.



End of Section E

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