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**Tasmanian Certificate of Education**

# **MATHEMATICS - APPLIED**

**Senior Secondary 5C**

*Subject Code: MAP5C*

**External Assessment**

**2004**

**Part 1 – Algebraic Modelling**

**Time: approximately 36 minutes**

On the basis of your performance in this examination, the examiners will provide results on the following criteria taken from the syllabus statement:

**Criterion 6** Select and apply algebraic or graphical models to analyse and solve problems in linear and non- linear modelling situations.

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Pages: 11  
Questions: 4

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## **CANDIDATE INSTRUCTIONS**

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No other printed material is allowed into the examination.

1. **ALL** questions in this section should be attempted.
2. Answers must be written in the spaces provided on the examination paper.
3. In total it is recommended that you spend approximately 36 minutes answering the questions in this section.
4. Graph paper is provided in the booklet when required.
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6. You are expected to provide a graphics calculator approved by the Tasmanian Qualifications Authority.

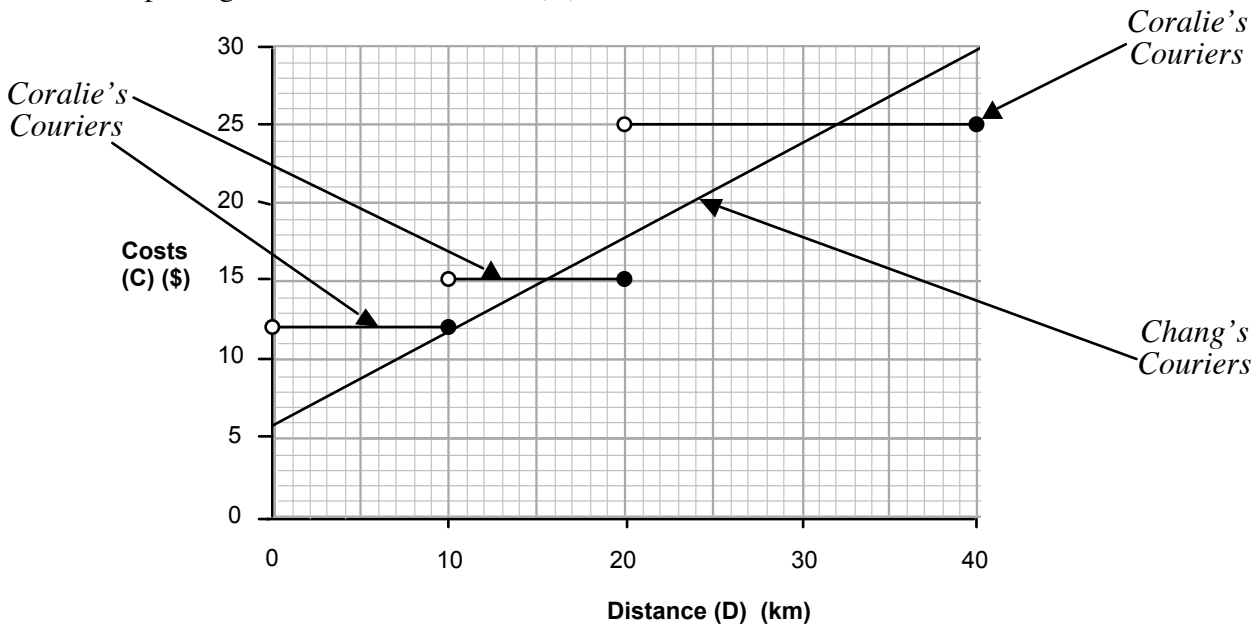
**Spare graph paper has been provided in the back of the booklet for you to use if required.**

**If you use the spare graph, you MUST indicate you have done so in your answer to that question.**

**Question 1** (Approximately 6 minutes)

Two courier companies, *Coralie's Couriers* and *Chang's Couriers*, charge their customers on the basis of the distance travelled to deliver a parcel. A graph showing the costs (C) to carry a standard package for distance travelled (D) is shown below.

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- (a) Describe in words or equation form, where applicable, the cost schedules for:

**C B**

*Coralie's Couriers*

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*Chang's Couriers*

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- (b) Discuss when it would be best to use *Coralie's Couriers* and when it would be best to use *Chang's Couriers*. No calculations are necessary.

**C B**

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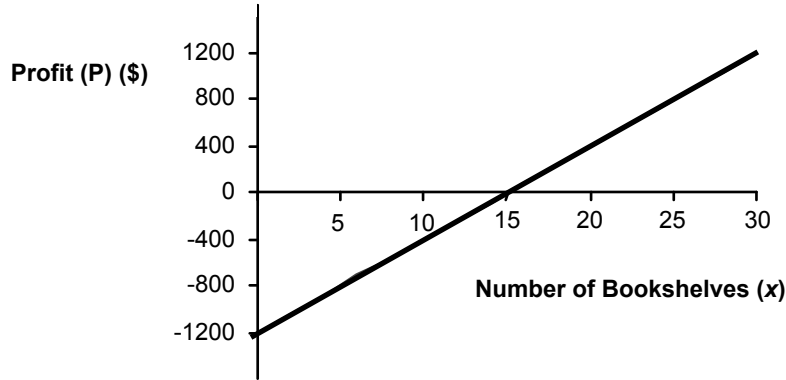
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**Question 2** (Approximately 5 minutes)

Barry makes bookshelves and sells them for \$120 each.

A graph of his profit equation is shown below.



(a) What is Barry’s revenue equation?

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(b) Determine Barry’s profit equation.

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(c) Use the profit equation and the revenue equation to determine Barry’s cost equation.

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**C**

**C B**

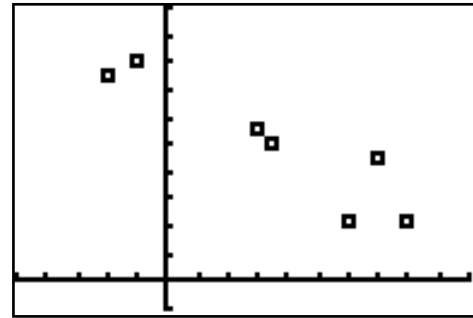
**C B A**

**Question 3** (Approximately 15 minutes)

An environmental scientist records the level of smoke pollution  $P$  (in micrograms per cubic metre) in Launceston against the minimum temperature  $T$  ( $^{\circ}\text{C}$ ) over a one week period during the winter of 2003.

A scatter plot of the data is shown.

Day	Minimum Temperature ( $^{\circ}\text{C}$ ) $T$	Smoke Pollution (micrograms per cubic metre) $P$
1	6	22.8
2	3.5	51.0
3	3	56.0
4	-1	80.9
5	-2	74.6
6	7	49.0
7	8	22.3



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- (a) Determine the linear regression model for this data. Give your numbers to one decimal place.

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- (b) Find the correlation coefficient ( $r$ ) and the coefficient of determination ( $r^2$ ) for this data. Draw a conclusion based on these.

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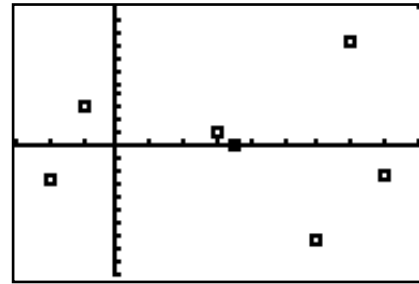
**C B**

**C B A**

**Question 3 continues opposite.**

**Question 3 (continued)**

A residuals plot for this linear model is shown opposite.



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- (c) Comment on the residuals plot. How well does the data appear to fit the linear model chosen?

**C B**

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The scientist considers that the measurement made on day 6 was an **outlier**. She decides to remove this outlier and to remodel the data using an exponential regression equation.

- (d) **Remove the outlier** from the data on day 6, and determine the **exponential regression** equation for the six remaining data points in the form:

**C B**

$P = ab^T$  (or  $P = ae^{bT}$ ). Give your numbers to 2 decimal places.

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- (e) Use your equation to predict what the pollution level will be when the minimum temperature is 9°C. Is it reasonable to use your equation to predict the pollution level at this temperature of 9°C? Explain.

**C B**

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- (f) Discuss the validity of the exponential regression model and the scientist’s decision to remodel the relationship. How well does this exponential model seem to fit the data?

**C B A**

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**Question 4** (Approximately 10 minutes)

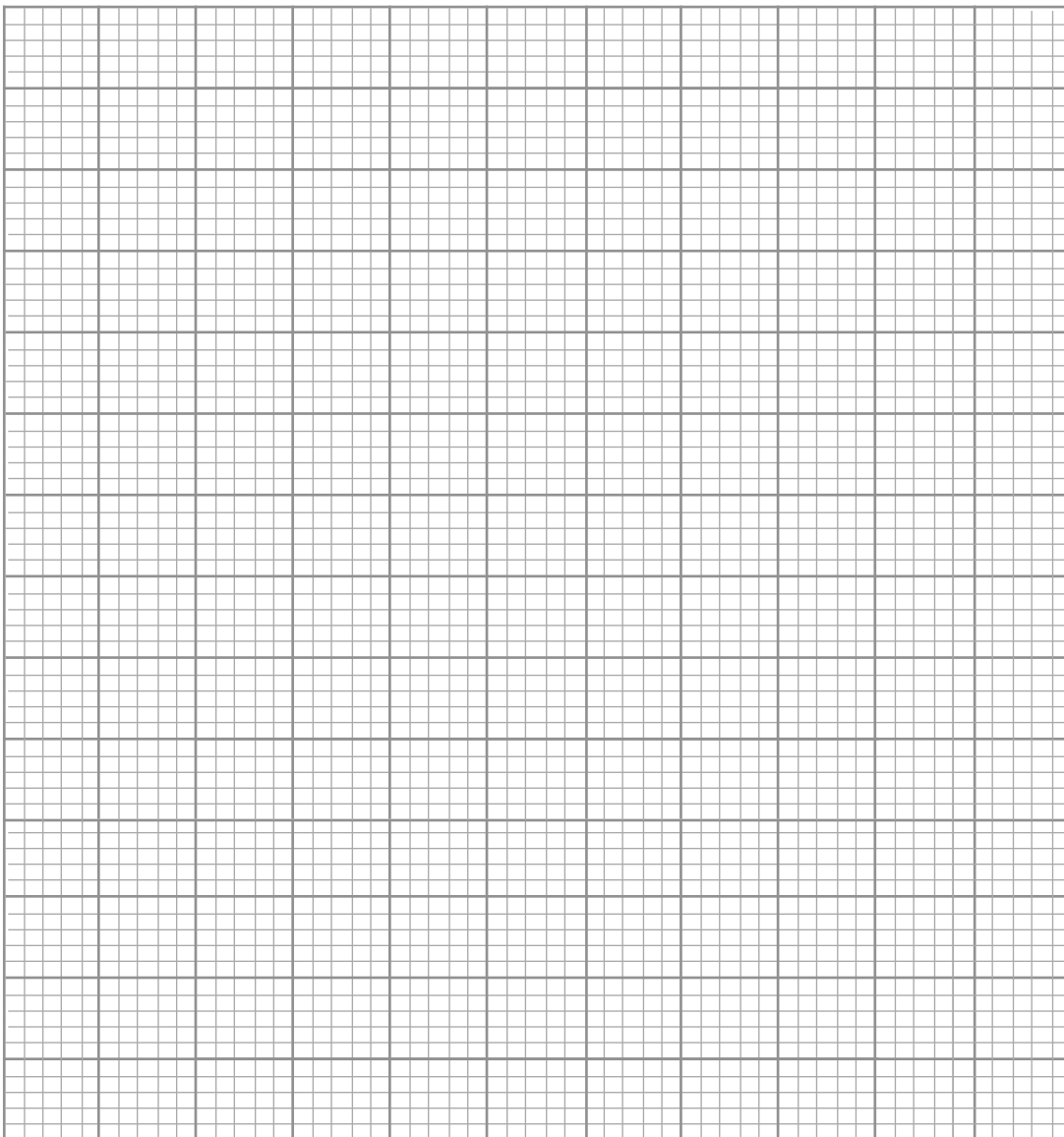
*Alinta Gas* charge the following daily costs (C) based on the amount of gas units (G) used each day according to the scale below:

**For  
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<b>Gas units used each day G</b>	<b>Daily Cost C (\$)</b>
0 to 12 units	\$0.10 per day plus \$0.07 per unit
12 to 36 units	\$0.94 per day plus \$0.046 cents for each unit over 12 units
Over 36 units	\$2.044 per day plus \$0.034 cents per unit over 36 units

**C B A**

- (a) Draw a graph of daily cost (C) against gas units used each day (G) for up to a maximum of 50 gas units per day.



**Question 4 continues opposite.**

**Question 4 (continued)**

- (b) Determine the equation that describes the relationship between the daily cost (C) and the gas units used each day (G) for the second stage of the graph (i.e. from 12 to 36 units of gas). Leave numbers to three decimal places.

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- (c) Use the equation in (b) to find the daily cost (C) for a household that uses 25 gas units each day.

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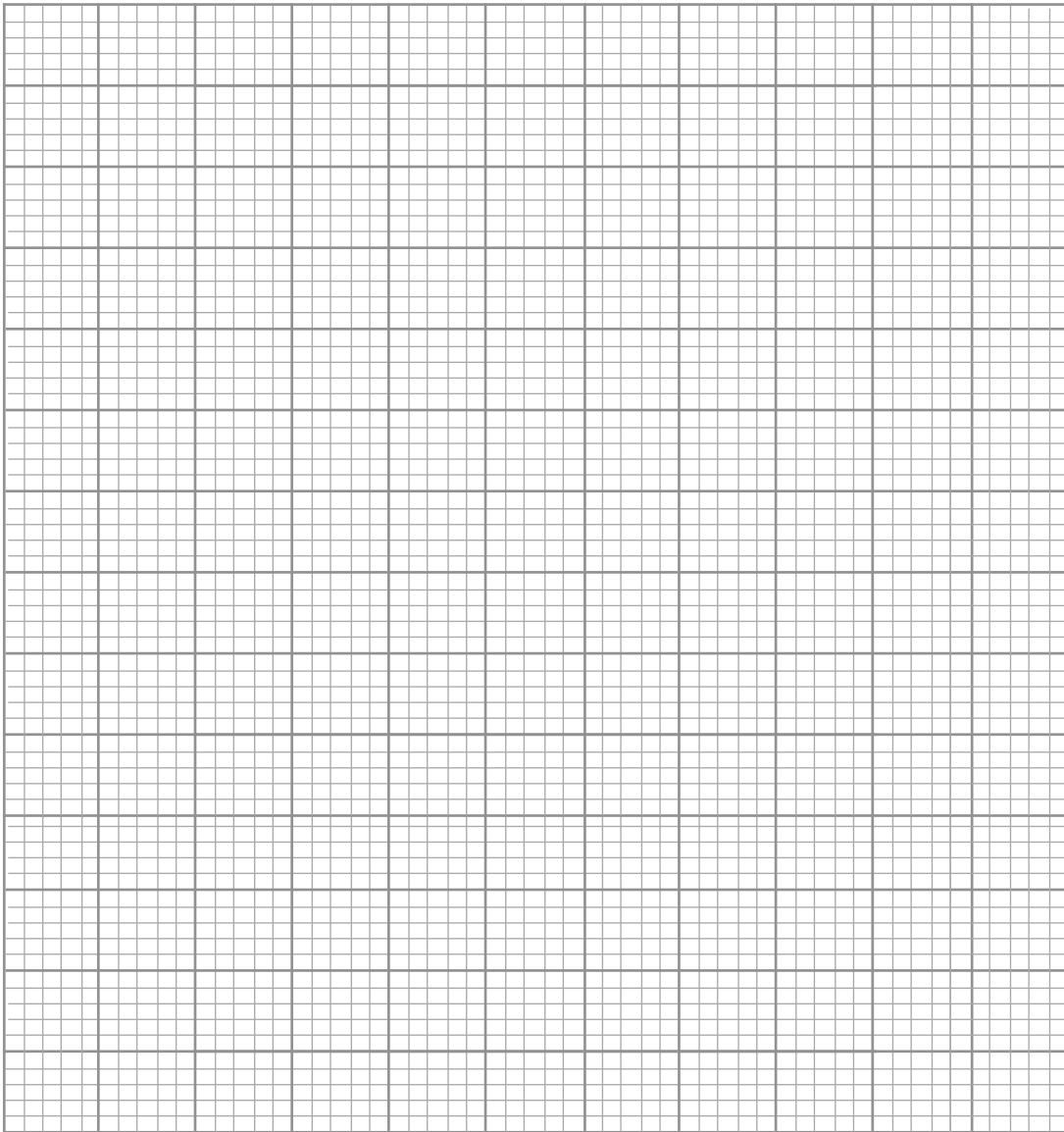
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**C B**

**C**

**Spare Graph for Question 4 (a)**

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**Tasmanian Certificate of Education**

# **MATHEMATICS - APPLIED**

**Senior Secondary 5C**

*Subject Code: MAP5C*

**External Assessment**

**2004**

**Part 2 – Calculus**

**Time: approximately 36 minutes**

On the basis of your performance in this examination, the examiners will provide results on the following criteria taken from the syllabus statement:

**Criterion 7** Use calculus to analyse and solve problems.

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Pages: 11  
Questions: 5

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## CANDIDATE INSTRUCTIONS

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No other printed material is allowed into the examination.

1. **ALL** questions in this section should be attempted.
2. Answers must be written in the spaces provided on the examination paper.
3. In total it is recommended that you spend approximately 36 minutes answering the questions in this section.
4. Graph paper is provided in the booklet when required.
5. Logical and mathematical presentation of answers and the statement of the arguments leading to your answer will be considered when assessing this part.
6. You are expected to provide a graphics calculator approved by the Tasmanian Qualifications Authority.

**A spare page for a screen plot has been provided in the back of the booklet for you to use if required.**

**If you use this spare page, you MUST indicate you have done so in your answer to that question.**

**Question 5** (Approximately 5 minutes)

A small Tasmanian company produces wooden bowls. The company finds that its profits ( $P$ ) vary according to the number of bowls ( $b$ ) that they produce and can be modelled by the equation:

$$P = -0.3b^2 + 42b - 800$$

where  $b$  is the number of wooden bowls produced and  $P$  is the profit in dollars.

- (a) What is the profit when they produce 30 bowls?

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- (b) Use **calculus** to determine the number of bowls produced to obtain the **maximum** profit.

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- (c) Determine the company's maximum profit.

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**C**

**C B**

**C**

**Question 6** (Approximately 4 minutes)

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A book publishing company asks a mathematician to investigate how the selling price (S) of a book will affect the profit (P) that they will make from its sales.

She produces the following table which shows how the selling price (S) of the book will determine the profit (P) produced.

Selling price (\$)	Profit (\$)
S	P
30	5900
50	20500
70	27900
90	28100
110	21100
130	6900

She finds that the relationship between P and S can be modelled as a **quadratic function**.

- (a) Use your **calculator** to determine the **quadratic function** that best models the profit function for this book.

**C B**

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- (b) Use your **calculator** to determine the selling price that will achieve the maximum profit.

**C**

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**Question 7** (Approximately 5 minutes)

An historian studying the number of deaths due to the bubonic plague in a European city during the fifteenth century found that this could be modelled according to the equation:

$$D = -1.8t^3 + 52t^2 + 80t + 70$$

where  $D$  is the number of deaths and  $t$  is the number of weeks after an outbreak of the bubonic plague.

- (a) How many deaths were reported one week after the outbreak of the bubonic plague?

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- (b) Find  $\frac{dD}{dt}$ . Explain what this means in terms of the variables given.

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- (c) Find the death rate 20 weeks after the outbreak of the plague, and 22 weeks after the outbreak. Explain what this means in terms of the question.

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**C B**

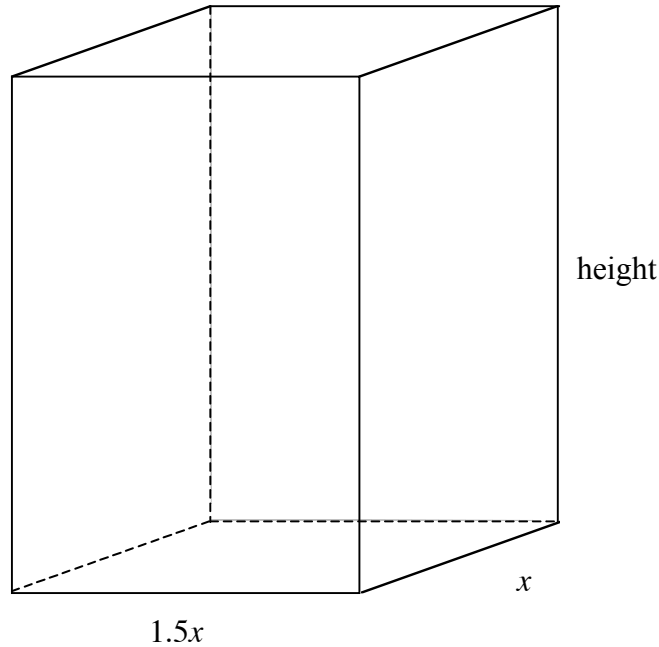
**C B A**

**Question 8** (Approximately 11 minutes)

*Classic Foods* produce and package liquid foods on contract for other companies.

Their standard package is designed so that the width is 1.5 times its base length ( $x$ ). It is constructed so that the **sum of the height, width and base is 33 cm**.

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- (a) Show that the volume of the package is given by the expression:

$$V = -3.75x^3 + 49.5x^2$$

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**C B A**

**Question 8 continues opposite.**



**Question 9** (Approximately 11 minutes)

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The weeds on a sporting field were treated with a weed killer and the number of weeds remaining were then counted over a 21 day period after the treatment.

It was found that the equation relating weeds remaining could be modelled as:

$$W = 2.1t^3 - 75t^2 + 625t + 1100$$

Where  $W$  is the number of weeds remaining and  $t$  is the number of days after the weedkiller was applied.

- (a) Use the equation to determine the initial number of weeds on the sporting field.

**C**

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- (b) Using your **calculator's screen plot function**, draw a graph in the space below, showing how the number of weeds varies for 21 days after the weed killer was applied. Show the end points on the graph (i.e. at the start and the finish of the graph) and the maximum and minimum values.

**C B**

**Question 9 continues opposite.**

**Question 9 (continued)**

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(c) Find  $\frac{dW}{dt}$ . Give your coefficients to one decimal place.

**C**

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(d) What is the rate of change of the number of weeds 7 days after the weed killer was applied?

**C B**

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(e) Discuss the effectiveness of the weed killer over the 21 day time period.

**C B A**

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**Spare Space for Question 9 (b)**

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**Tasmanian Certificate of Education**

# **MATHEMATICS - APPLIED**

**Senior Secondary 5C**

*Subject Code: MAP5C*

**External Assessment**

**2004**

**Part 3 – Applied Geometry**

**Time: approximately 36 minutes**

On the basis of your performance in this examination, the examiners will provide results on the following criteria taken from the syllabus statement:

**Criterion 8**      Use geometrical models to solve problems.

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Pages:        11  
Questions:    5

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**Question 10** (Approximately 3 minutes)

Carole who lives in Calgary (51°N, 114°W) phones her friend Alice who is in Athens (38°N, 24°E). If Carole makes this call at 5:25 pm (Calgary standard time), at what time (Athens standard time) does Alice receive the phone call?

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**C B**

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**Question 11** (Approximately 5 minutes)

James is on top of Mt. Warning in NSW (latitude 28°S) at an elevation of 1156 m watching the sunrise over the ocean due east of him.

- (a) If the **radius of the earth is 6371 km**, what is the straight line distance from James to the point on the horizon where the sun is first observed?

**C B**

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- (b) Later in the day James notes that the sun is at its highest point when it is 0147 hours GMT. Determine the **position** of Mt Warning.

**C B**

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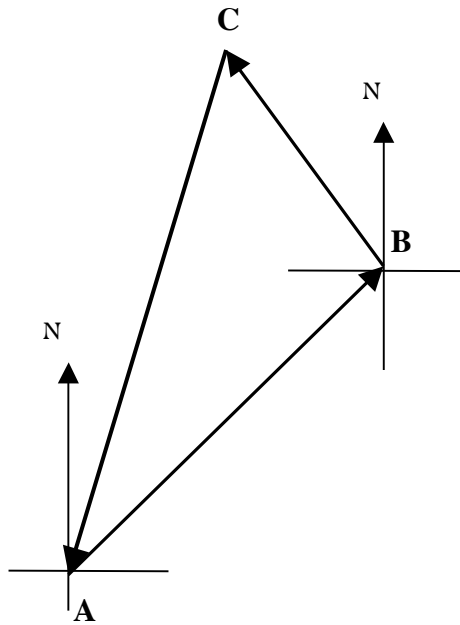
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**Question 12** (Approximately 6 minutes)

A cross country race course on flat ground has runners heading from point A for 3.5 km on a bearing of  $047^\circ\text{T}$  to point B. From B they turn and run for 2.8 km on a bearing of  $342^\circ\text{T}$  to point C. They then run back to point A.

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- (a) Determine the distance from C back to A.

**C B**

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- (b) At what bearing does the course follow from C back to A?

**C B A**

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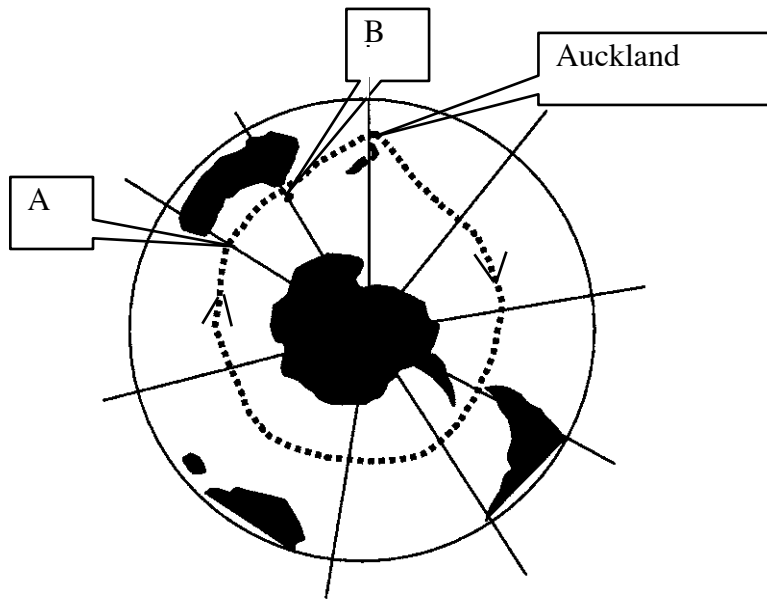
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**Question 13** (Approximately 14 minutes)

The *Antarctica Cup* is an ocean yacht race that involves sailing around the Antarctic continent. The race starts and finishes in Auckland (New Zealand) as shown below.

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The last two sections of the race takes the boats from point A ( $40^{\circ}\text{S}$ ,  $116^{\circ}\text{E}$ ) **due east** to point B ( $40^{\circ}\text{S}$ ,  $147^{\circ}\text{E}$ ). From point B the yachts head **directly** to Auckland ( $37^{\circ}\text{S}$ ,  $174^{\circ}\text{E}$ ).

- (a) Find the time zones for A, B and Auckland.

**C**

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- (b) Find the distance in **nautical miles** between:

- (i) Point A and point B.

**C B**

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**Question 13 continues opposite.**

**Question 13 (continued)**

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(ii) Point B and Auckland.

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**C B A**

(c) During the race the leading yacht *Stormbird* left point A at 1:45 pm on February 7<sup>th</sup> (Point A standard time) and arrived in Auckland at 4:45 am (Auckland standard time) on February 14<sup>th</sup>. Determine *Stormbird*'s average speed in knots.

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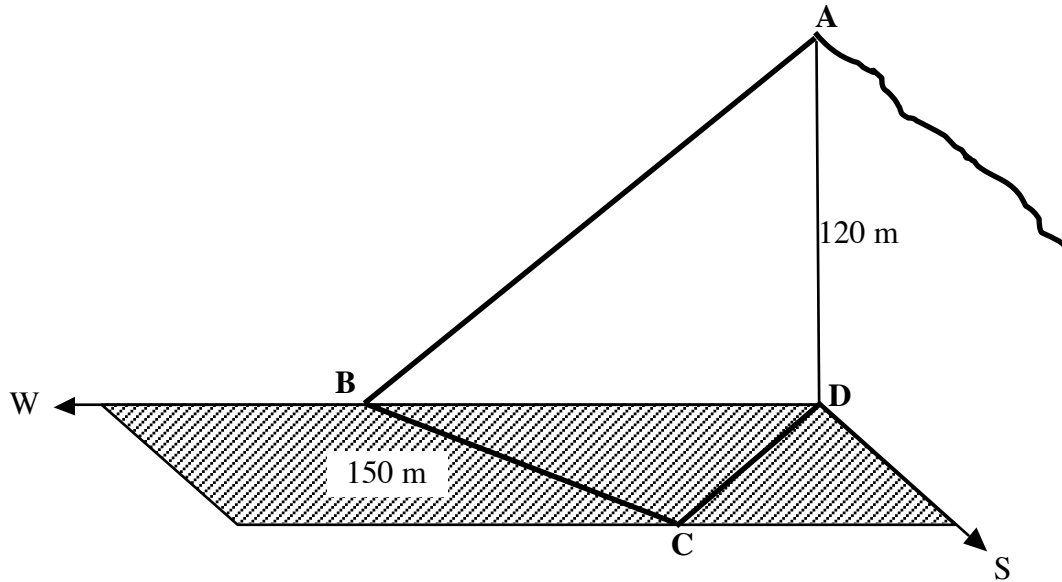
**C B A**

**Question 14** (Approximately 8 minutes)

Sally (A) is on the top of a 120 m high cliff (AD) watching her friend Kerry (C) in a sea kayak below her at a bearing of  $S30^\circ W$ .

Sally (A) notices a buoy (B) due west of her at an angle of depression of  $50^\circ$ .

Kerry (C) is 150 m from the buoy (B).



- (a) How far is the buoy (B) from the base of the cliff (D)?

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**Question 14 continues opposite.**

**Question 14 (continued)**

(b) Determine the bearing of the buoy (B) from Kerry (C).

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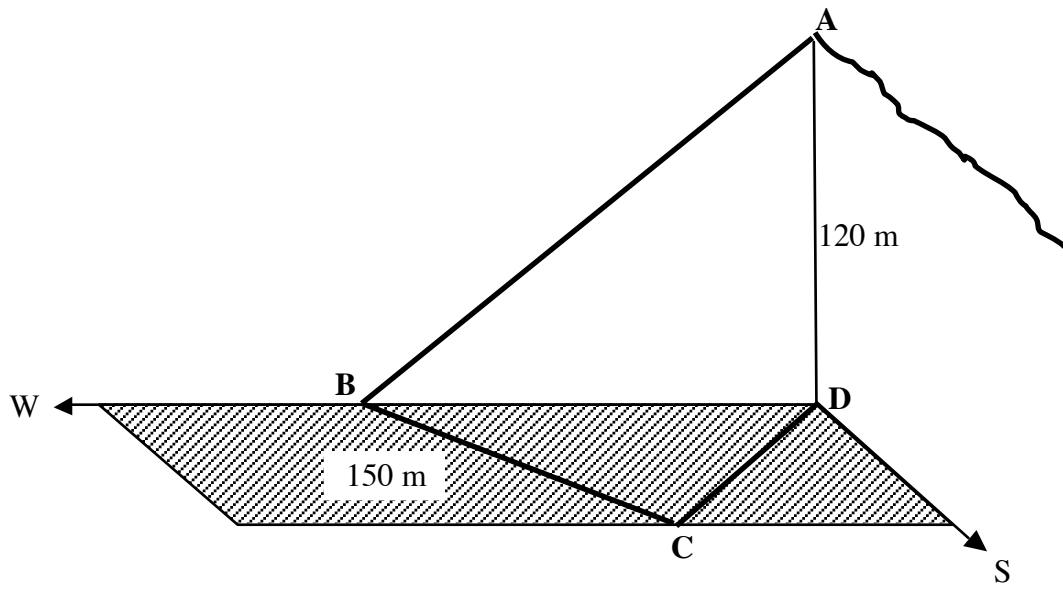
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**C B**

Spare Diagram for Question 14

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**Tasmanian Certificate of Education**

**MATHEMATICS - APPLIED**

**Senior Secondary 5C**

*Subject Code: MAP5C*

**External Assessment**

**2004**

**Part 4 – Data Analysis**

**Time: approximately 36 minutes**

On the basis of your performance in this examination, the examiners will provide results on the following criteria taken from the syllabus statement:

**Criterion 9** Analyse and describe distribution data associated with populations and samples.

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Pages: 11  
Questions: 5

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**Question 15** (Approximately 3 minutes)

During July a real estate agent in a Tasmanian town sold thirteen houses. The mean selling price was \$190 000 whilst the median price was \$149 000.

Which would be the more useful measure for a prospective house buyer? Explain your answer.

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**C B**

**Question 16** (Approximately 7 minutes)

In this question sketches showing the relevant area under the normal distribution curve should accompany your working out and answers.

The mean height of adult Australian males is 174.2 cm with a standard deviation of 7.4 cm.

- (a) Predict the percentage of Australian males who would be less than 160 cm tall.

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In a town there are 2545 adult males.

- (b) How many adult males in this town would be expected to be between 170 and 180 cm in height?

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- (c) What is the minimum height a doorway should be so that fewer than 50 males in this town need to bend when walking through?

Are there any other considerations that should be made about this minimum height?  
 Show all relevant working out and reasoning.

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**C B A**

**Question 17** (Approximately 5 minutes)

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A transport authority is investigating whether there is a relationship between the age of a car and its minimum stopping distance. They tested seven cars of differing ages (months) and found out the minimum stopping distances (metres) that the cars can achieve at 50 km per hour. The results are shown in the table below.

Age of car (months)	Stopping distance (m)
12	28.4
48	29.3
65	37.6
97	36.2
34	36.5
43	35.3
89	44.1

- (a) Find Pearson’s correlation coefficient for the data and draw a conclusion based upon your result.

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As a result of these tests a representative of the transport authority makes the claim that; ‘As a car gets older this **causes** its stopping distance to increase’.

- (b) Comment on the limitations of this investigation and the conclusion they have reached.

**C B A**

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**Question 18** (Approximately 10 minutes)

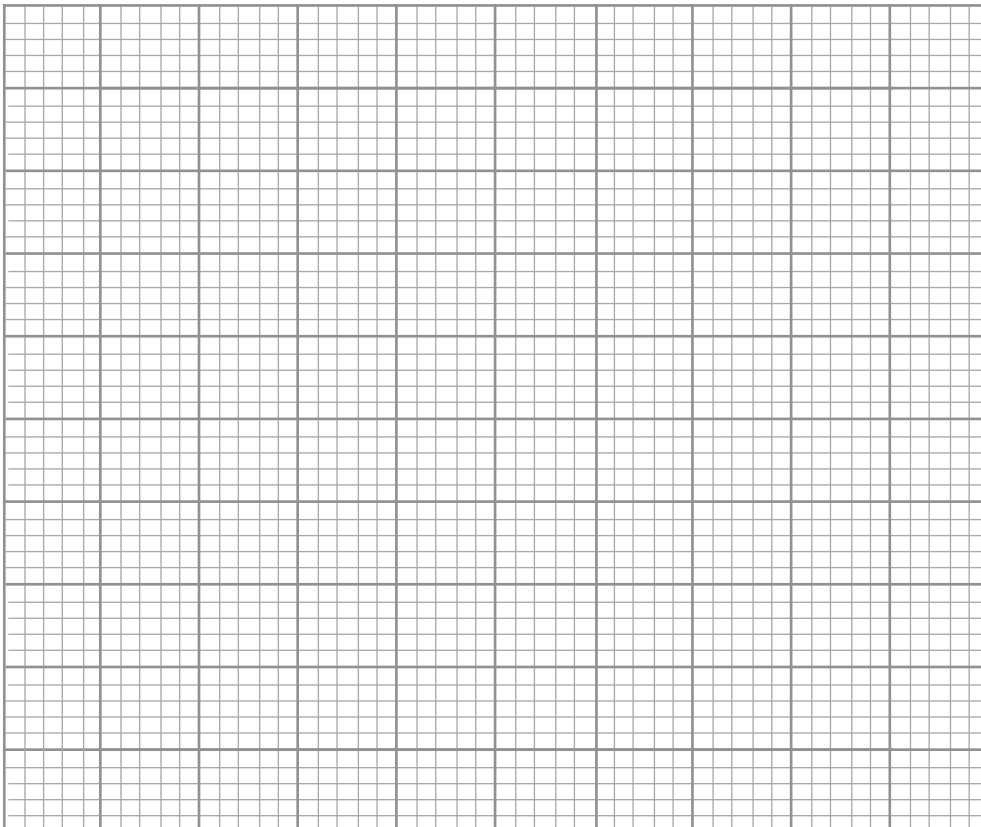
The maximum temperatures for Adelaide over the first 180 days of the year 2003 are recorded in the table below.

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temperature (°C)	days	cf (for working)
10 – 15	12	
15 – 20	28	
20 – 25	52	
25 – 30	58	
30 – 35	19	
35 – 40	8	
40 – 45	3	

- (a) Draw an ogive of the data on the graph paper. Include a percentage axis.

**C B A**



**Question 18 continues opposite.**

**Question 18 (continued)**

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(b) Find the 25<sup>th</sup> percentile, the median and the 75<sup>th</sup> percentile. Label these on your ogive.

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**C**

(c) How many days had maximum temperatures above 38°C? Indicate this on your ogive.

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**C B**

**Question 19** (Approximately 11 minutes)

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As part of a class investigation, twelve Maths Applied students decided to see if it took longer to do their homework when listening to music than when they didn't listen to music.

The students recorded the time it took them to complete a set of homework problems whilst listening to some music (Music) and then the time that it took them to complete a similar set of problems without listening to music (No Music).

The results are shown in the table below:

<b>Student</b>	<b>Music (minutes)</b>	<b>No Music (minutes)</b>
A	18	17
B	17	23
C	23	28
D	32	30
E	28	26
F	18	20
G	19	21
H	33	26
I	24	13
J	25	15
K	32	19
L	33	22

- (a) Write down the **five figure summaries** for both the music and no music cases (lowest scores, lower quartiles, medians, upper quartiles and highest scores).

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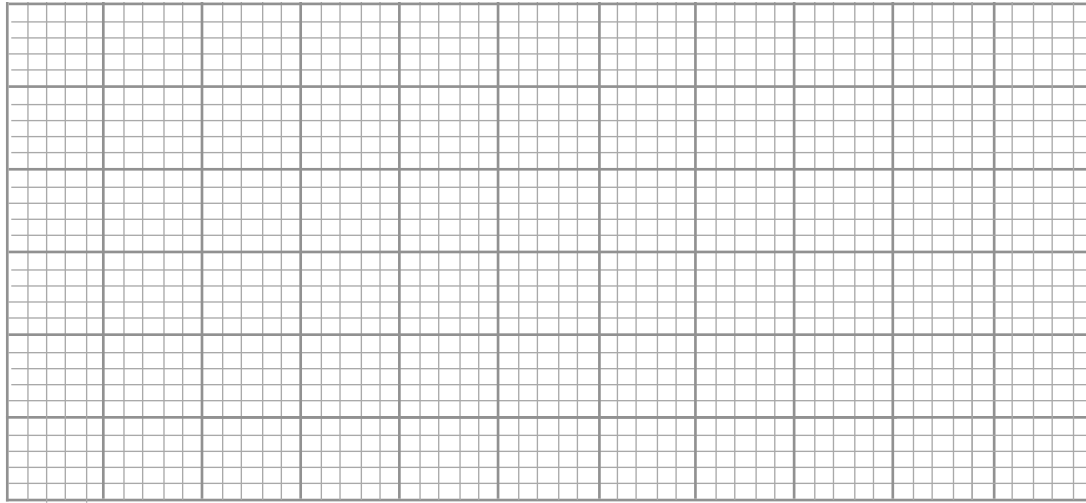
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**Question 19 continues opposite.**

**Question 19 (continued)**

(b) Draw side by side box plots of the data from (a) below.



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**C B**

(c) Use the box plots to make comparisons between the time these students took to complete the homework problems with and without music.

**C B A**

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(d) Use a suitable t-test to test the hypothesis that; ‘it takes longer to do homework when listening to music than when you don’t listen to music’. Write a suitable conclusion.

**C B A**

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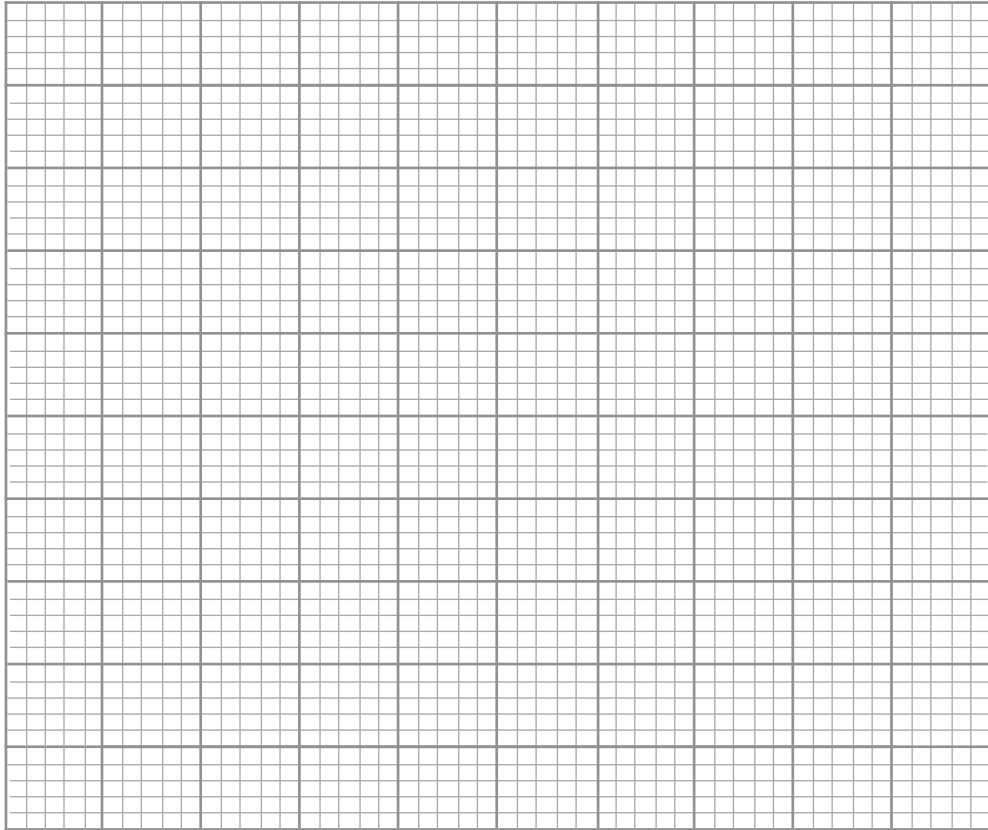
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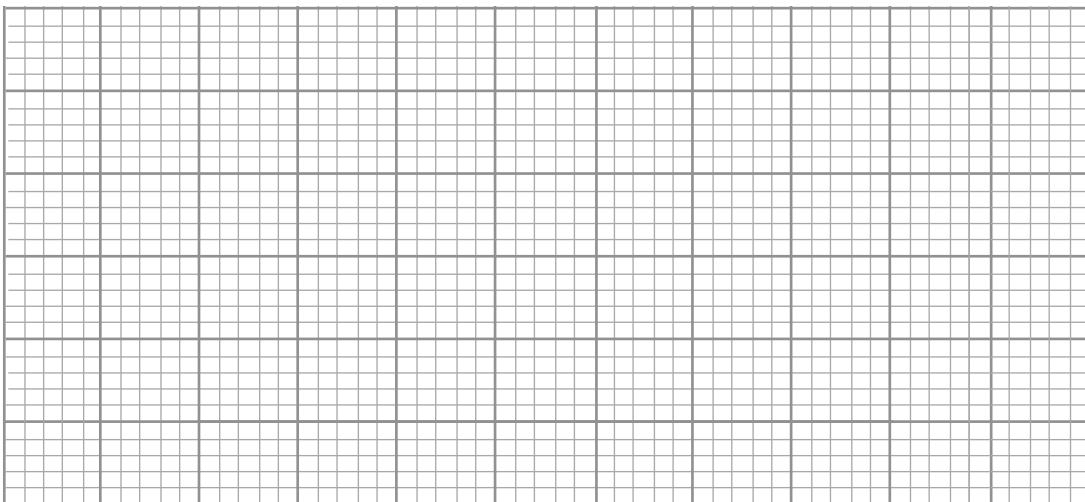
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**Spare Graph for Question 18 (a)**



**Spare Graph for Question 19 (b)**



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PLACE LABEL HERE

**Tasmanian Certificate of Education**

**MATHEMATICS - APPLIED**

**Senior Secondary 5C**

*Subject Code: MAP5C*

**External Assessment**

**2004**

**Part 5 – Finance**

**Time: approximately 36 minutes**

On the basis of your performance in this examination, the examiners will provide results on the following criteria taken from the syllabus statement:

**Criterion 10** Demonstrate a working knowledge of the standard financial models.

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Pages: 11  
Questions: 5

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## CANDIDATE INSTRUCTIONS

The 2004 Mathematics Applied 5C Formulae Sheet can be used throughout the examination.

No other printed material is allowed into the examination.

1. **ALL** questions in this section should be attempted.
2. Answers must be written in the spaces provided on the examination paper.
3. In total it is recommended that you spend approximately 36 minutes answering the questions in this section.
4. Graph paper is provided in the booklet when required.
5. Logical and mathematical presentation of answers and the statement of the arguments leading to your answer will be considered when assessing this part.
6. You are expected to provide a graphics calculator approved by the Tasmanian Qualifications Authority.

**Question 20** (Approximately 3 minutes)

**For  
Marker  
Use  
Only**

*Ozzieloans* is a ‘payday loan’ company that will lend money to almost anybody for 15 days. As they only lend money for very short periods they charge **extremely high** interest rates.

*Ozzieloans* advertise a loan for \$300 which has to be repaid in 15 days time with one repayment of \$375.

Determine the simple interest rate (p.a.) for this loan. Give your answer to one decimal place. (Show algebraic working).

**C**

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**Question 21** (Approximately 5 minutes)

*Fleur's Florists* bought a second hand van for \$12000 with the intention of replacing it in three years time. They allowed for a depreciation rate of 20% pa on the **reducing balance** of this van.

(You may use your calculator's financial mode in answering this question.)

- (a) Work out the value of the second hand van in three years time.

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The current price of the new van that they intend to buy in three years time is \$32900 and the inflation rate for this van is 2.5% pa.

- (b) Assuming that they can sell their second hand van for the price found in (a), determine how much extra that they will have to pay in three years time to buy a new van.

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**For  
 Marker  
 Use  
 Only**

**C**

**C B**



**Question 23** (Approximately 8 minutes)

**For  
Marker  
Use  
Only**

Peter decides to buy a plasma screen TV for \$5995 from the *Super Store*.

He has the choice of purchasing the TV **either** with:

*Super Store's* 'Buy now with  $\frac{1}{3}$  deposit and six months interest free loan' **or** *ANY Bank's* personal loan.

The conditions for both loans are shown below. Both loans run for two years.

<i>Super Store Loan</i>
$\frac{1}{3}$ deposit 6 months interest free and no repayments for 6 months THEN 28.5% reducible interest loan on balance after deposit 18 months equal monthly repayments

<i>ANY Bank Personal loan</i>
11.5% reducible interest loan 24 months equal monthly repayments

- (a) Use words and figures to describe and compare each of these loans in terms of total monthly repayments and interest paid.

**C B A**

(You may use your calculator's financial mode in this problem).

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**Question 23 continues opposite.**

**Question 23 (continued)**

**For  
Marker  
Use  
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(b) On the basis of your findings briefly summarise the merits, or otherwise, of both loans.

**C B**

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**Question 24** (Approximately 12 minutes)

**For parts (a) and (b) of this question you MAY use your calculator’s financial mode. For parts (c) and (d) you MUST show algebraic workings.**

**For  
Marker  
Use  
Only**

Gail wishes to save up a total of \$8000 in order to go to Europe in four years time.

A bank offers Gail an interest rate of 5.45% (**effective** p.a.) compounded monthly.

- (a) Find the nominal interest p.a.  
(You may use your calculator’s financial mode).

**C**

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- (b) How much should Gail invest monthly in order to reach this savings target?  
(You may use your calculator’s financial mode).

**C B**

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- (c) If Gail invests \$150 per month, determine how much Gail has saved after two years?  
(Algebraic workings **MUST** be shown).

**C B**

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**Question 24 continues opposite.**

**Question 24 (continued)**

Part way into her savings plan, Gail decides that she only requires \$7000 in savings.

- (d) How long will it take Gail to reach \$7000 in savings?  
(Algebraic workings **MUST** be shown).

**For  
Marker  
Use  
Only**

**C B A**

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