

2013 VCE Further Mathematics Trial Examination 2



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STUDENT NUMBER

Figures									Letter
Words									

VICTORIAN CERTIFICATE OF EDUCATION 2013 FURTHER MATHEMATICS

Trial Written Examination 2 (Analysis task)

Reading time: 15 minutes
Total writing time: 1 hour 30 minutes

QUESTION AND ANSWER BOOK

Structure of book Core

Number of questions	Number of questions to be answered
3	3

Modules

Number of modules	Number of modules to be answered
6	3

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, one bound reference, one approved graphics calculator or approved CAS calculator or CAS software and, if desired, one scientific calculator. Calculator memory DOES NOT need to be cleared.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.

Materials supplied

- Question and answer book of 37 pages.
- Working space is provided throughout the book.
- There is a detachable sheet of miscellaneous formula supplied.

Instructions

- Detach the formula sheet from the book during reading time.
- Write your **student number** in the space provided above on this page.
- All written responses must be in English.

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

FURTHER MATHEMATICS

Written examinations 1 and 2

FORMULA SHEET

Directions to students

Detach this formula sheet during reading time.

This formula sheet is provided for your reference.

Further Mathematics Formulas

Core: Data analysis

standardised score:	$z = \frac{x - \bar{x}}{s_x}$
least squares line:	$y = a + bx \text{ where } b = r \frac{s_y}{s_x} \text{ and } a = \bar{y} - b\bar{x}$
residual value:	residual value = actual value – predicted value
seasonal index:	$\text{seasonal index} = \frac{\text{actual figure}}{\text{deseasonalised figure}}$

Module 1: Number patterns

arithmetic series:	$a + (a + d) + \dots + (a + (n-1)d) = \frac{n}{2}[2a + (n-1)d] = \frac{n}{2}(a + l)$
geometric series:	$a + ar + ar^2 + \dots + ar^{n-1} = \frac{a(1-r^n)}{1-r}, r \neq 1$
infinite geometric series:	$a + ar + ar^2 + ar^3 + \dots = \frac{a}{1-r}, r < 1$

Module 2: Geometry and trigonometry

area of a triangle:	$\frac{1}{2}bc \sin A$
Heron's formula:	$A = \sqrt{s(s-a)(s-b)(s-c)} \text{ where } s = \frac{1}{2}(a+b+c)$
circumference of a circle:	$2\pi r$
area of a circle:	πr^2
volume of a sphere:	$\frac{4}{3}\pi r^3$
surface area of a sphere:	$4\pi r^2$
volume of a cone:	$\frac{1}{3}\pi r^2 h$
volume of a cylinder:	$\pi r^2 h$
volume of a prism:	area of base $\times$ height
volume of a pyramid:	$\frac{1}{3} \text{ area of base } \times \text{ height}$

Pythagoras' theorem: $c^2 = a^2 + b^2$

sine rule: $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

cosine rule: $c^2 = a^2 + b^2 - 2ab \cos C$

Module 3: Graphs and relations

Straight line graphs

gradient (slope): $m = \frac{y_2 - y_1}{x_2 - x_1}$

equation: $y = mx + c$

Module 4: Business-related mathematics

simple interest: $I = \frac{\text{Pr} T}{100}$

compound interest: $A = PR^n$ where $R = 1 + \frac{r}{100}$

hire purchase: effective rate of interest $\approx \frac{2n}{n+1} \times \text{flat rate}$

annuities: $A = PR^n - \frac{Q(R^n - 1)}{R - 1}$, where $R = 1 + \frac{r}{100}$

Module 5: Networks and decision mathematics

Euler's formula: $v + f = e + 2$

Module 6: Matrices

determinant of a 2×2 matrix: $A = \begin{bmatrix} a & b \\ c & d \end{bmatrix}; \det A = \begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$

inverse of a 2×2 matrix: $A^{-1} = \frac{1}{\det A} \begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$ where $\det A \neq 0$

END OF FORMULA SHEET

Specific Instructions

This task paper consists a core and six modules. Students should answer **all** questions in the core and then select **three** modules and answer **all** questions within the modules selected.

	Page
Core: Data analysis	2
Module	
Module 1: Number patterns and applications	8
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Core: Data analysis

Question 1

Mr. Wirhana owns two chocolate shops, one in Darceyville and the other in Gracetown. The weekly takings in thousands of dollars at both shops for the last 14 weeks are given in the table below.

Darceyville	Gracetown
20	10
14	7
8	9
5	12
6	15
13	18
10	15
12	12
13	11
10	10
10	12
11	14
12	16
13	18

The mean and standard deviation for the weekly takings over the last 14 weeks at the chocolate shop in Darceyville are \$11,214 and \$3683 respectively.

- a. What are the mean and standard deviation for the weekly takings over the last 14 weeks for the chocolate shop in Gracetown. Give your answer to the nearest dollar.

Mean: _____

Standard Deviation: _____

2 marks

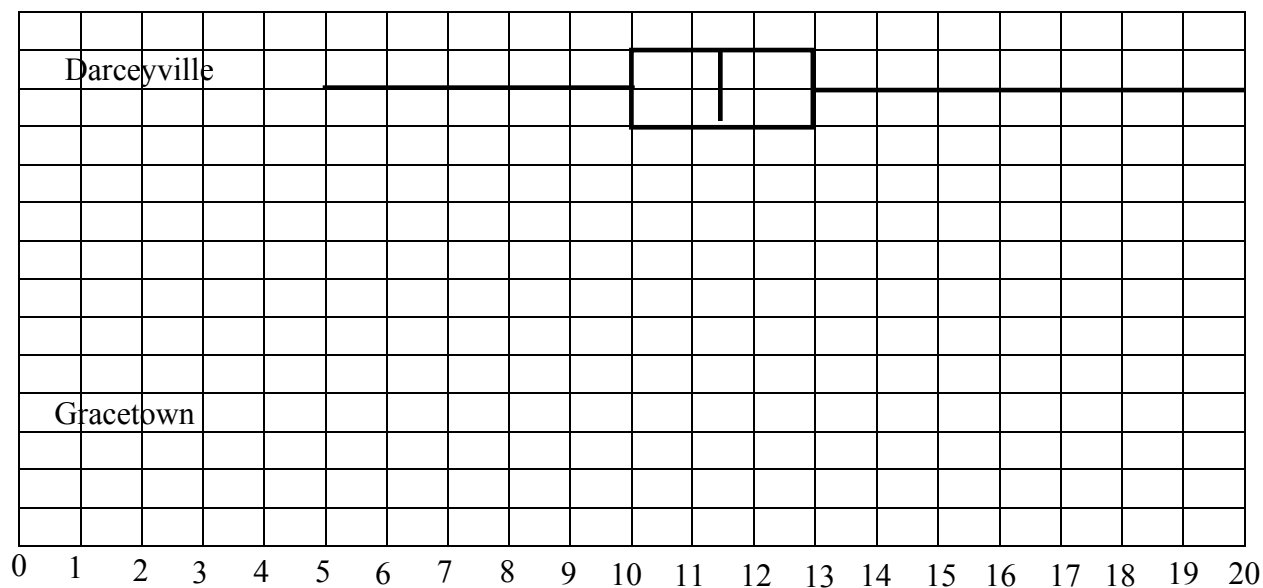
- b. Compare the takings for the two chocolate shops with regard to average takings and spread.

1 mark

Core: Data analysis

Question 1 (continued)

- c. Draw the box plot for Gracetown on the graph below.

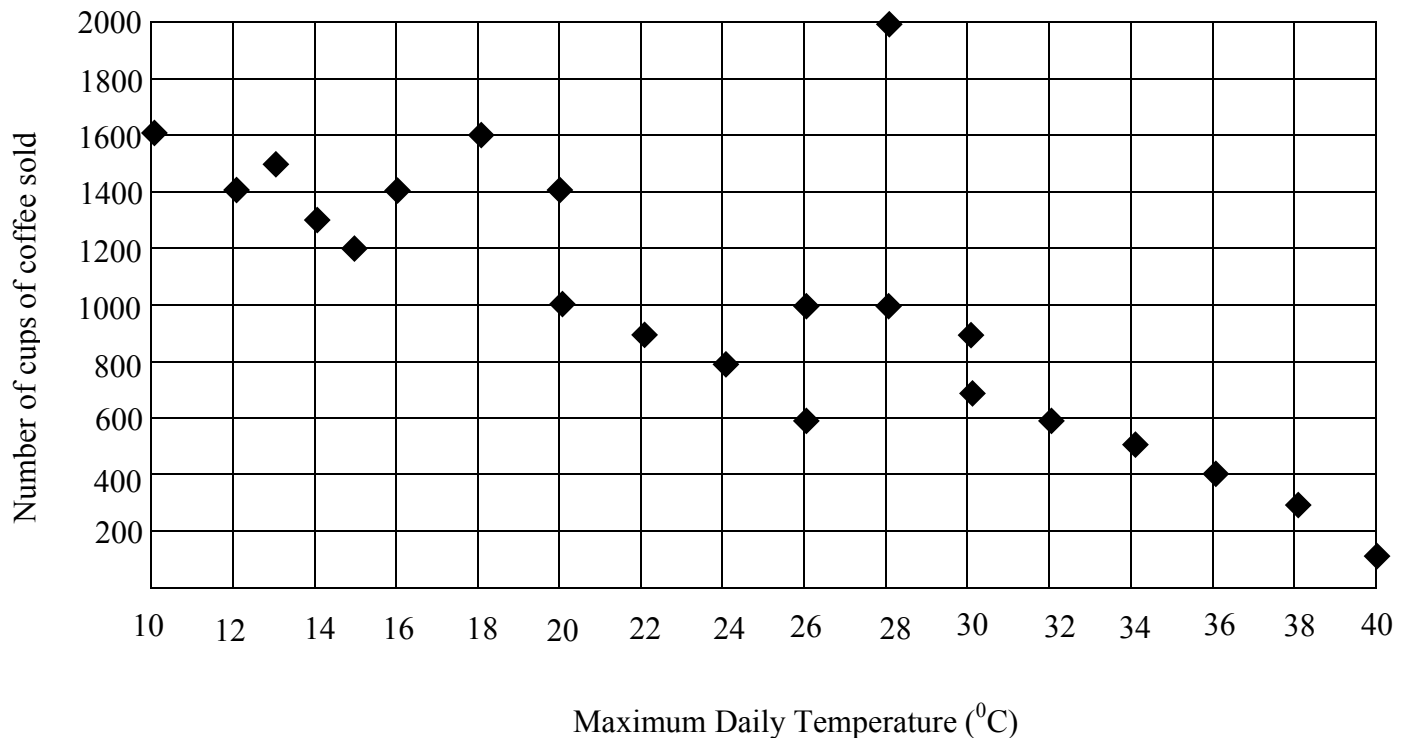


2 marks

Core: Data analysis

Question 2

Mr. Wirhana also sells coffee in his chocolate shops. Over a one - year period he records the average number of cups of coffee sold at the Darceyville shop, compared with the maximum daily temperature. The results are shown in the graph below.



- a. What is the dependent variable?

1 mark

- b. What is the slope of the 3 median line for the above data?

1 mark

Core: Data analysis

Question 2 (continued)

- c. Interpret the slope in the context of the problem.

1 mark

- d. Draw the 3 median line on the above graph.

1 mark

- e. Why is it better to use the three median line rather than the least squares regression line to describe this linear relationship?

1 mark

Core: Data analysis

Question 3

The results of the daily average number of cups of coffee sold at Mr. Wirhana's Gracetown chocolate shop compared with the maximum daily temperature are given in the table below.

Gracetown	
Maximum Daily Temperature	Average number of Cups of Coffee sold
10	1200
12	1000
13	900
15	1300
16	1000
18	950
20	860
21	880
23	850
25	820
27	800
29	700
30	650
33	630
34	500
36	480
38	470
40	450

- a.** What is the equation of the least squares regression line for this data?
Give all values to the nearest whole number.

1 mark

- b.** Use this equation to determine the residual value when the maximum daily temperature was 27°C.

1 mark

Core: Data analysis

Question 3 continued

- c. Describe the strength and direction of the linear relationship.

1 mark

- d. What is the coefficient of determination for this data? Give your answer to 4 decimal places.

1 mark

- e. Interpret this coefficient of determination in the context of the problem.

1 mark

Total = 15 marks

End of Core: Data analysis

Module 1: Number patterns and applications

If you choose this module, all questions are to be answered.

Question 1

Mitch plays cricket for the Junior Demons. His runs for each week of last season can be given by the following difference equation

$$R_{n+1} = 4R_n \quad R_1 = 2$$

- a. i.** How many runs did Mitch make in the 4th week?

1 mark

- a. ii.** Each term of the difference equation can be given by the rule

$$t_n = 2 \times r^{n-1}$$

What is the value of r ?

1 mark

- b.** Mitch's friend, Chris, has weekly runs that follow the rule

$$R_{n+1} = R_n + 3 \quad R_5 = 92$$

How many runs did Chris make in the first week of the season?

1 mark

- c.** Mitch's friend, Geoff, has weekly runs that follow the rule

$$R_{n+1} = aR_n + b \quad R_1 = c$$

Geoff's runs for the first 3 weeks of the season were 10, 12 and 16 respectively.

What are the values of a , b and c ?

a _____

b _____

c _____

3 marks

Module 1: Number patterns and applications

Question 2

Mitch is saving to buy a cricket bat for \$340. He saves \$2.00 the first week, \$3.20 the second week, \$4.40 the third week and so on.

- a.** How much will he save in the fourth week?

1 mark

- b.** How much will he save in the tenth week?

1 mark

- c.** How much will he have saved altogether by the end of 20 weeks?

1 mark

- d.** How many weeks altogether will he have to save before he has enough money to buy his cricket bat?

1 mark

Module 1: Number patterns and applications

Question 3

After Mitch has saved for 5 weeks, his grandmother says that she will give him \$3 in his 6th week of saving, \$6 in his 7th week of saving, \$12 in his 8th week of saving and so on, until he has enough money to buy his cricket bat, as long as he keeps saving as he has been doing.

- a. How much money will Mitch's grandmother give him in his 10th week of saving?

1 mark

- b. How much more will Mitch need to save to buy his cricket bat after his 10th week of saving?

1 mark

- c. In which week of Mitch's saving would his grandmother first give him more than \$100 for the week?

1 mark

- d. How many weeks altogether would Mitch have to save for his cricket bat?

1 mark

- e. In which week of Mitch's savings would his grandmother first make a weekly contribution that was more than double Mitch's contribution for that week?

1 mark

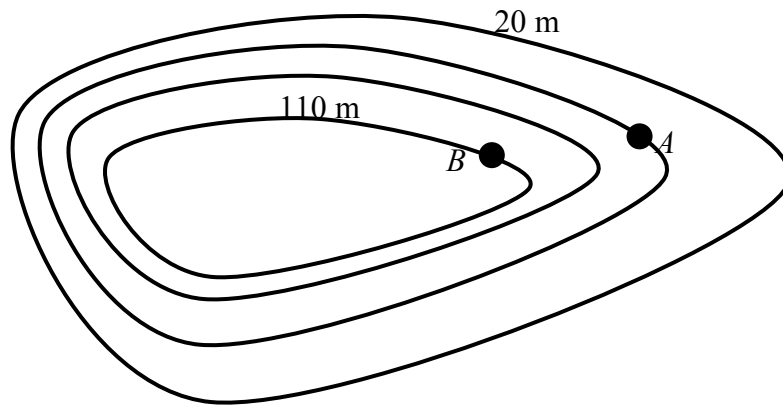
Total = 15 marks

End of Module 1: Number patterns and applications

Module 2: Geometry and trigonometry

If you choose this module, all questions are to be answered.

Question 1



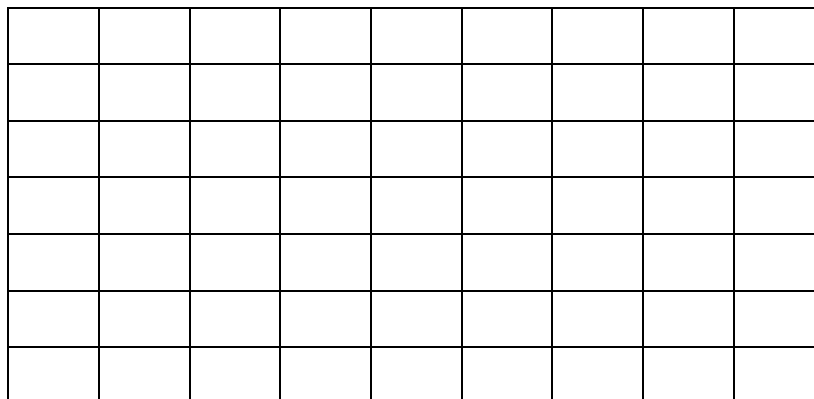
Scale: 1 : 500

The above is a contour map of an area of land.

- a. What height is A above sea level?

1 mark

- b. On the grid below, draw a profile showing the elevations of a line passing through A and B in the above contour.



1 mark

Module 2: Geometry and trigonometry

Question 1 (continued)

- c. If the horizontal distance from A to B is 35 cm on the map, what is the actual distance between these two points? Give your answer in metres.

1 mark

- d. What is the gradient of a road linking A to B ? Give your answer to 3 decimal places.

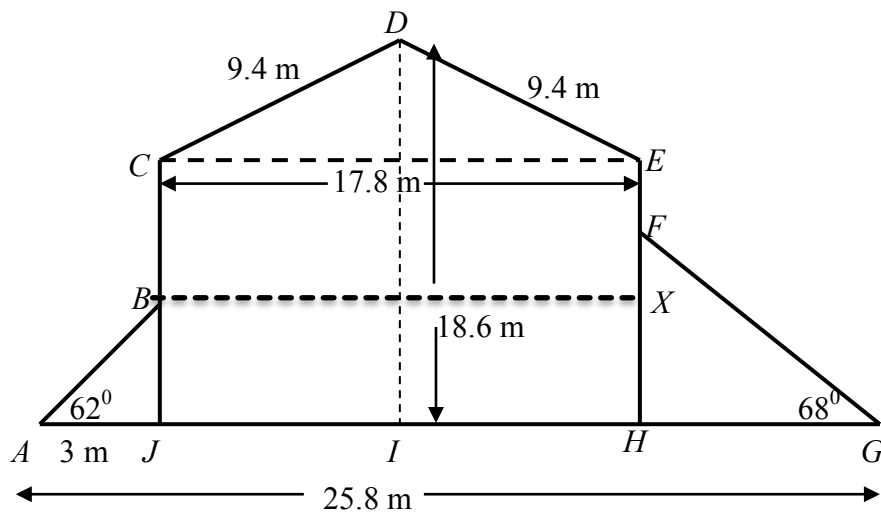
1 mark

- e. What angle does the road AB make with the horizontal?
Give your answer to the nearest degree.

1 mark

Module 2: Geometry and trigonometry

Question 2



The above shows one wall of a bird watching structure, which is built on one of the contour sites.

- a. What is the length of HG ?

1 mark

- b. What is the length of BJ ? Give your answer to two decimal places.

1 mark

- c. What is the magnitude of $\angle CDE$? Give your answer to one decimal place.

1 mark

Module 2: Geometry and trigonometry

Question 2 (continued)

- d.** What is the length of BF ? Give your answer to the nearest metre.

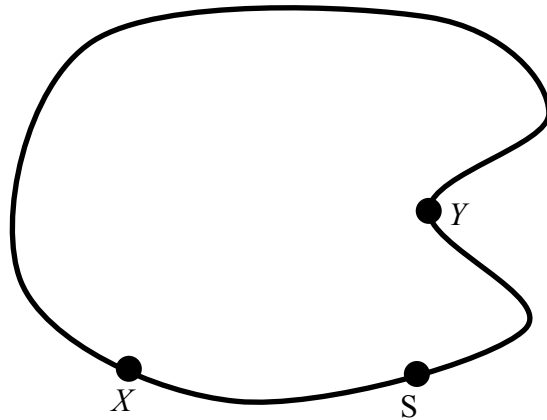
1 mark

- e.** What is the area of this wall? Give your answer to the nearest square metre.

1 mark

Module 2: Geometry and trigonometry

Question 3



A bridge is to be built across a small ornamental lake linking the bird watching structure at X to a point, Y , on the edge of the lake. A tree, Z , is growing 98 m from Y at a point such that the bearing of Y from Z is 130° T , and the bearing of X from Z is 155° T .

- a.** Mark the point Z on an appropriate spot on the diagram above.

1 mark

- b.** What is the magnitude of $\angle XZY$?

1 mark

- c.** If the bearing of X from Y is 240° T , what is the magnitude of $\angle ZYX$?

1 mark

Module 2: Geometry and trigonometry

Question 3 (continued)

- d. What is the length of the footbridge, XY ? Give your answer to one decimal place.

1 mark

- e. Charlie is in a paddle - boat traveling east from point X to point S . If she is paddling at 2 km per hour, how long will it take her to reach point S ? Give your answer to the nearest minute.

1 mark

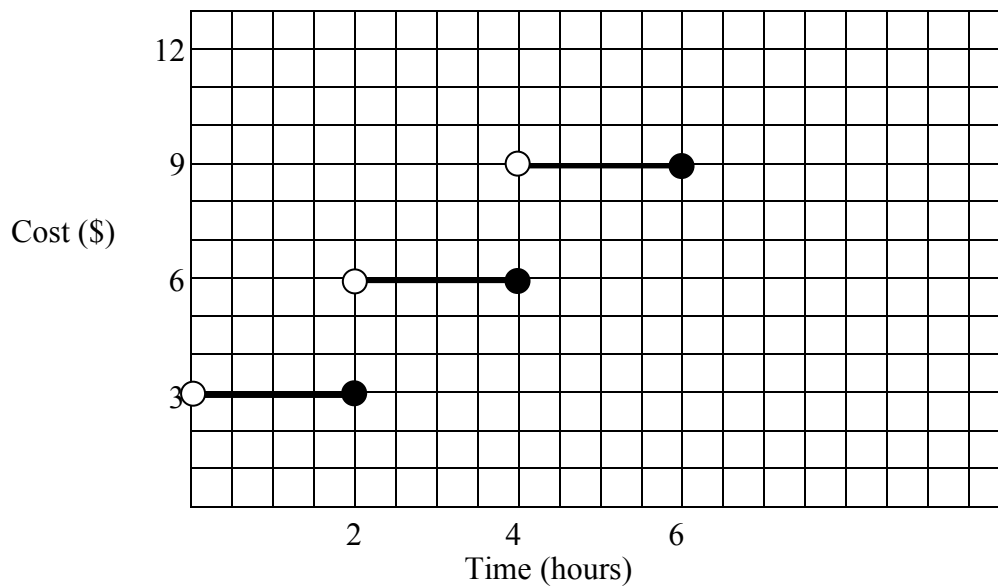
Total 15 marks

End of Module 2: Geometry and trigonometry

Module 3: Graphs and relations

If you choose this module, all questions are to be answered.

Question 1



The cost of parking at Collinvale shopping centre for up to 6 hours is shown in the graph above. The cost of parking for more than 6 hours is \$12.

- a. Complete the above graph to show the parking costs for parking for any length of time.

1 mark

- b. How much would it cost to park for 1 hour?

1 mark

Module 3: Graphs and relations

Question 1 (continued)

- c. Ali parks at the shopping centre for 9 hours while he catches the train to his work place.
How much more will he pay for his parking than Serina, who parks for 2 hours?

1 mark

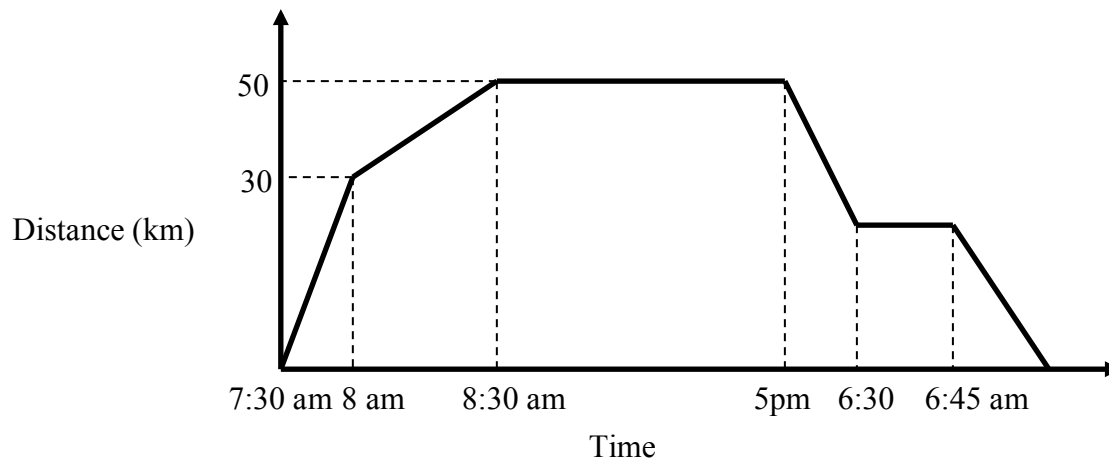
- d. Complete the equation of the graph showing the cost of parking in dollars.

$$\begin{cases} C = 3, & \text{-----} \\ C = 6, & \text{-----} \\ C = 9, & \text{-----} \\ C = & \text{-----} \end{cases}$$

2 marks

Module 3: Graphs and relations

Question 2



The above graph, which is not drawn to scale, shows the movements of Ali's car. He left home at 7:30 one morning to drive to Collindale shopping centre where he left his car while he caught the train to work. On the way home he stopped to get petrol.

- a.** How long did he stop to get petrol?

1 mark

- b.** How far is the shopping centre from his home?

1 mark

- c.** What is his slowest speed when he is traveling to the shopping centre?

1 mark

Module 3: Graphs and relations

Question 2 (continued)

- d.** If the petrol station is 45 km from the Collindale car park, and if Ali drove from the petrol station to home at twice the speed that he drove from the car park to the petrol station, at what time did he arrive home?

2 marks

Module 3: Graphs and relations

Question 3

Ali's company makes two types of cars, Alphas and Betas. A profit of \$3000 is made on each Alpha car and \$2500 on each Beta car produced. The company cannot make more than 12 cars per week and no more than 9 Alpha cars can be produced in a week. A Beta car takes 15 hours to build and an Alpha car takes 30 hours to build and the total time the car making machines are used each week is not more than 300 hours.

- a. If x Alpha cars and y Beta cars are produced each week by this company, then two of the constraints are

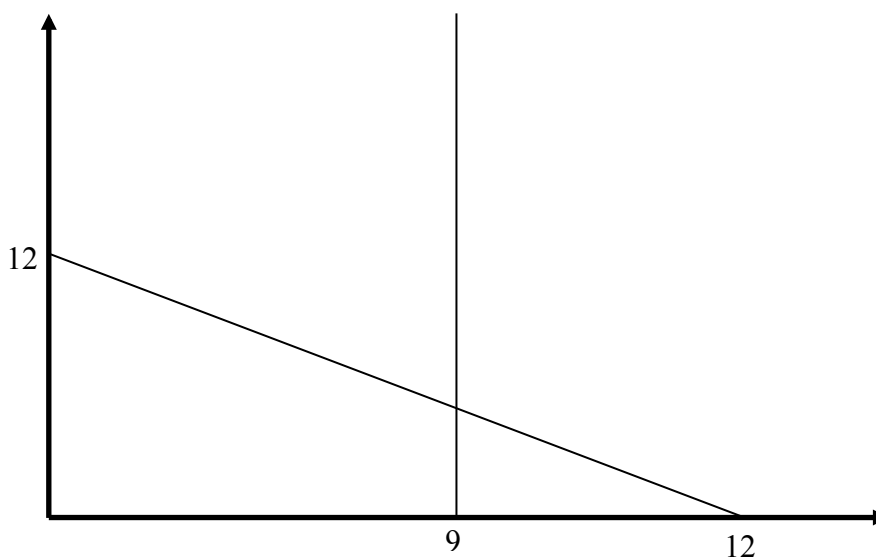
$$x + y \leq 12$$

$$x \leq 9$$

Write down the missing constraint involving the time for building the cars.

1 mark

- b. On the graph below, draw the line of the missing constraint showing the x and y intercepts.



1 mark

- c. On the graph above, shade the region that satisfies all the constraints.

1 mark

- d. What is the maximum Profit that Ali can make each week?

1 mark

Module 3: Graphs and relations

Question 3 (continued)

- e. The table below shows the percentage tax that Ali has to pay depending on his total profit.

Profit (P)	Tax (%)
$P \leq \$30000$	28
$30000 < P \leq 32000$	30
$P > 32000$	45

To maximize his after tax profit, how many of each type of car should Ali produce each week?

1 mark

Total = 15 marks

End of Module 3: Graphs and relations

Module 4: Business-related mathematics

If you choose this module, all questions are to be answered.

Question 1

Tran owns a shop where he sells his vases for a 20% profit.

- a. What would be the selling price of a vase that cost him \$32 to buy?

1 mark

- b. What would the cost price have been for a vase that Tran sold for \$180?

1 mark

- c. Tran has a sale once a year when he sells his vases at 10% discount. What would the cost price of a vase have been if the selling price at the sale was \$270?

1 mark

- d. Glenda works for Tran and is entitled to a 5% discount. How much profit will Tran make on a vase that Glenda buys at the sale if the vase cost Tran \$500?

1 mark

Module 4: Business-related mathematics

Question 2

Tran's bank statement for the period from 1st February to 30th April is shown below.

Date	Debit	Credit	Balance
1 Feb			\$1400
15 Feb		\$450	\$1850
26 Feb			\$1630
3 March		\$1600	\$3230
10 March		\$80	\$3310
28 March	\$440		
2 April		\$100	\$2970
6 April	\$1200		\$1770
20 April		\$6000	\$7770
30 April		Interest	

- a. i.** What amount is missing from the bank statement for the 26th February?

1 mark

- ii.** What was the balance on the 28th March?

1 mark

- b.** Interest is paid at a rate of 5.6% per annum on the minimum monthly balance.

- i.** What was the minimum monthly balance for March?

1 mark

- ii.** How much interest should Tran receive on 30th April for the given 3 month period?
Give your answer to the nearest ten cents.

1 mark

Module 4: Business-related mathematics

Question 3

Tran wants to renovate his shop and finds that the renovations will cost \$350000. He has \$80,000 in a savings account, which he will use for the renovations and agrees to borrow the rest of the money at 6.3% interest per annum adjusted monthly. If he repays the money in equal monthly instalments over 10 years

- a. i.** How much will he repay each month?

1 mark

- ii.** How much interest will he pay?

1 mark

If, after 2 years of repaying the money, Tran finds that he can repay an extra \$800 per month,

- b. i.** How many more months will it take for him to repay the loan?

1 mark

- ii.** How much less interest will he pay by paying the extra \$800 per month?
Give your answer to the nearest dollar.

1 mark

Module 4: Business-related mathematics

Question 4

Tran plans to retire from his business in thirty years time. He wants to have enough money when he retires to put into a perpetuity account so as to be able to have a monthly income of \$3000. The interest rate of the perpetuity is 5.8% per annum.

- a. i.** How much money does Tran need to put into the perpetuity account? Give your answer to the nearest dollar.

1 mark

- ii.** How much of the original money that Tran puts in the perpetuity account will be used up if Tran lives for 20 years after retirement?

1 mark

- b.** If Tran can get an interest rate today of 7.5% per annum, how much should he invest today at this fixed rate so as to achieve his required perpetuity? Assume that Tran will put no more money into this account. Give your answer to the nearest dollar.

1 mark

Total = 15 marks

End of Module 4: Business-related mathematics

Module 5: Networks and decision mathematics

If you choose this module, all questions are to be answered.

Question 1

The following matrix was constructed to show the number of roads connecting any two towns.

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
<i>A</i>	0	0	0	1	2
<i>B</i>	0	0	0	0	0
<i>C</i>	0	0	0	1	1
<i>D</i>	1	0	1	0	1
<i>E</i>	2	0	1	1	0

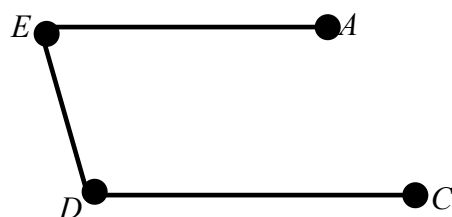
- a. Explain why there are zeros on the diagonal that is marked with a dotted line.

1 mark

- b. Explain why the second row and the second column contain only zeros.

1 mark

- c.



Complete the above network for the given matrix by including the missing roads and vertex.

2 marks

Module 5: Networks and decision mathematics

Question 1 (continued)

- d. A fun run must pass through each town at least once, and the runner must run every road only once. A new road is to be built to enable this to be done. Between which two towns could the new road be built?

1 mark

Question 2

Jack, Kate, Len, Maya and Nina are to act as guides for the fun run, one in each of the five towns. The following grid shows the times in minutes for each of them to reach the centre of the various towns from their respective homes.

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
Jack	7	18	17	7	9
Kate	12	19	8	18	12
Len	8	10	15	10	14
Maya	14	17	19	10	16
Nina	9	16	14	13	9

The coordinator has to allocate a town to each person, based on the fact that the total time for them to reach their respective towns must be a minimum.

- a. Complete the first step of the Hungarian algorithm in the table below.

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
Jack	0	11	10	0	2
Kate	4	11	0	10	4
Len	0	2	7	2	6
Maya	4	7	9	0	6
Nina					

1 mark

Module 5: Networks and decision mathematics

Question 2 (continued)

- b.** What is the smallest number of lines that can be used to cover the zeros in the table after step 1 of the Hungarian algorithm is completed?

1 mark

- c.** Complete the Hungarian algorithm using the table below.

	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>E</i>
Jack					
Kate					
Len					
Maya					
Nina					

1 mark

- d.** Allocate each guide to a town.

Town	Guide
<i>A</i>	
<i>B</i>	
<i>C</i>	
<i>D</i>	
<i>E</i>	

1 mark

- e.** What is the total time taken for all the guides to reach their respective towns?

1 mark

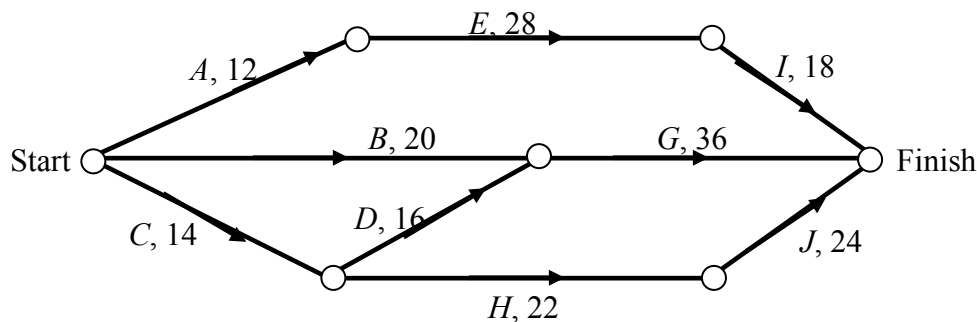
Module 5: Networks and decision mathematics

Question 3

In a house-building project, the architect has identified ten activities that must be completed before the house is finished. The table below shows the activities that must be completed before another activity can begin and the duration time in weeks for each activity.

Activity	Immediate Predecessor	Expected duration
A	–	12
B	–	20
C	–	14
D	C	16
E	A	28
F	B, D	15
G	B, D	36
H	C	22
I	E, F	18
J	H	24

- a. Complete the network for the project in the following diagram.



1 mark

- b. What is the critical path?

1 mark

Module 5: Networks and decision mathematics

Question 3 (continued)

- c. What is the minimum number of weeks that the project will take?

1 mark

- d. What is the earliest expected starting time for activity I?

1 mark

- e. What is the slack time for activity E?

1 mark

Total = 15 marks

End of Module 5: Networks and decision mathematics

Module 6: Matrices

If you choose this module, all questions are to be answered.

Question 1

$$\begin{bmatrix} 3 & -2 \\ 6 & p \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} a \\ b \end{bmatrix}$$

- a.** For what value of p would the above matrix equation have no unique solution for x and y ?

1 mark

- b.** If p has the value found above and if $b = 2a$, how many solutions to the equations
 $3x - 2y = a$
 $6x + py = b$
are possible? Give a reason for your answer.

1 mark

Module 6: Matrices

Question 2

The time, in days, for an artist to complete the various parts of different types of painting are given in the matrix, A , below.

$$A = \begin{matrix} & \begin{matrix} \text{Landscape} & \text{Portrait} & \text{StillLife} & \text{Naive} \end{matrix} \\ \begin{matrix} \text{Canvas} \\ \text{Outline} \\ \text{Colour} \end{matrix} & \begin{bmatrix} 0.2 & 0.5 & 0.3 & 0.4 \\ 2 & 4 & 5 & 0.9 \\ 12 & 8 & 16 & 20 \end{bmatrix} \end{matrix}$$

- a. What is the order of the above matrix?

1 mark

- b. What does the element, 4, in the matrix represent?

1 mark

- c. The artist charges \$50 for each day spent on a landscape, \$45 for each day spent on a portrait, \$60 for each day spent on a still life and \$32 for each day spent on a naïve painting. Set up a column matrix, B , to show this information.

1 mark

Module 6: Matrices

Question 2 (continued)

d. Find the matrix AB .

1 mark

e. What does the element in the third row, first column of AB represent?

1 mark

Module 6: Matrices

Question 3

In an art school, of the people who painted a landscape last week, 90% will paint a landscape this week, 5% will paint a portrait this week and 5% will paint a still life this week. Of the people who painted a portrait last week, 80% will paint a portrait this week, 10% will paint a landscape this week and 10% will paint a still life this week. Of the people who painted a still life last week, 70% will paint a still life this week, 20% will paint a landscape this week and the remainder will paint a portrait this week.

- a. What percentage of the people who painted a still life last week will paint a portrait this week?

1 mark

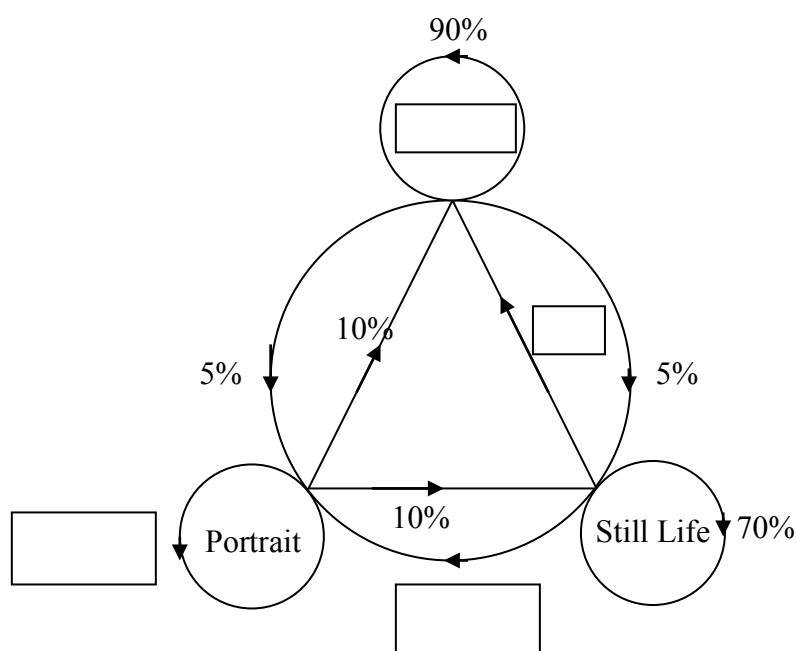
- b. Set up the transition matrix, T , that will show the given information.

1 mark

Module 6: Matrices

Question 3 (continued)

- c. Complete the following diagram, which can be used to display the information given by the transition matrix, T .



2 marks

Module 6: Matrices

Question 3 (continued)

There are 1000 students in the art school. In the first week 300 students painted a landscape, 400 did a portrait and the remainder did a still life.

- d. What is the steady state matrix, S_0 ?

1 mark

- e. How many students would be expected not to change their type of painting at the end of the first week?

1 mark

- f. How many students would you expect to paint a portrait in the fourth week?

1 mark

- g. In the long run, how many students would you expect to paint a landscape each week ?

1 mark

Total = 15 marks

End of Module 6: Matrices

**End of 2013 Further Mathematics Trial Examination 2
Question and Answer Book**

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