

2012

VCE

Further Mathematics

Trial Examination 2



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PURPOSE OF THIS TRIAL EXAMINATION

This Further Mathematics Trial Examination is designed to assess

- understanding and communication of mathematical ideas
- interpretation, analysis and solution of routine problems
- interpretation, analysis and solution of non-routine problems

Assessment is by extended answer questions involving multi-stage solutions of increasing complexity.

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STUDENT NUMBER

Letter

Figures									
Words									

VICTORIAN CERTIFICATE OF EDUCATION
2012
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 36 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:
$$\text{residual value} = \text{actual value} - \text{predicted value}$$

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:
$$\pi r^2$$

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:
$$\text{area of base} \times \text{height}$$

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	7
Module 2: Geometry and trigonometry	12
Module 3: Graphs and relations	17
Module 4: Business-related mathematics	21
Module 5: Networks and decision mathematics	25
Module 6: Matrices	30

Core: Data analysis**Question 1**

Male	Female
16.4	19.4
17.4	17.6
17.5	18.6
17.3	21.2
17.3	21.1
17.5	19.0
18.5	24.4
18.4	21.4
18.2	19.1
18.1	21.4
31.1	20.4
29.3	24.2

The above table shows the times in minutes, taken by males and females in the swim section of a triathlon. The mean and standard deviation for the males is 19.8 and 4.9 respectively.

- a. Find the mean and standard deviation for the females. Give your answers to one decimal place.

2 marks

- b. What percentage of females swam faster than the mean swim time for the males? Give your answer to one decimal place.

1 mark

- c. Compare the spread for the males and females in the swim division.

1 mark

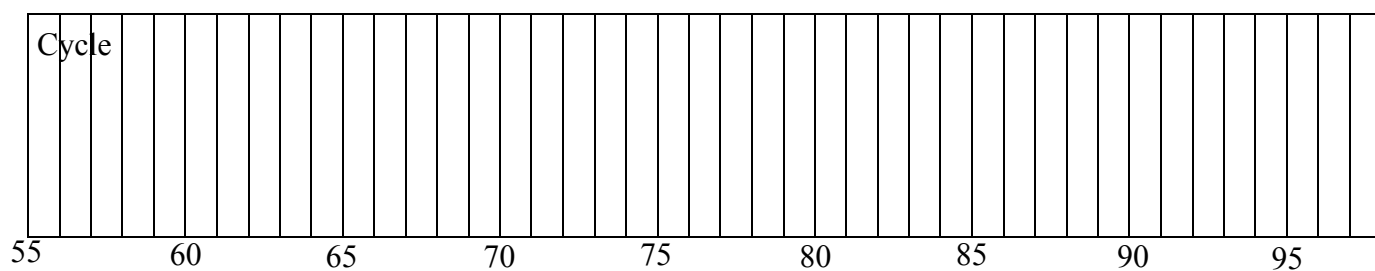
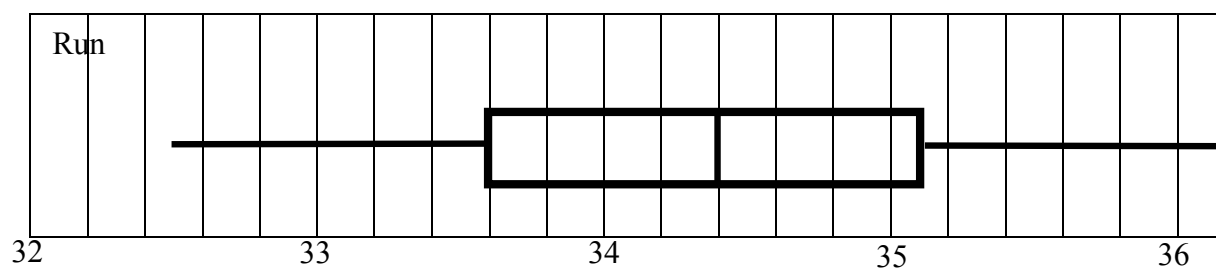
Core: Data analysis**Question 2**

Cycle	Run
55.3	34.4
58.3	32.5
60.0	33.3
59.4	33.5
60.1	34.4
59.1	34.2
59.0	34.5
59.3	35.3
61.5	35.2
59.1	36.2
94.0	33.7
88.2	35.0

The above table gives the times, in minutes, of males in the different sections of a triathlon.

Below is the box plot for the running section for males.

- a. i.** On the graph below the running box plot, draw a box plot for the cycling section for males. Show all outliers.



3 marks

Core: Data analysis**Question 2 (continued)**

- a. ii.** What percentage of the triathletes took more than 59.1 minutes for the cycling section?

1 mark

- b.** Do the running times have any outliers? Use an appropriate calculation to support your explanation.

2 marks

- c.** What is the range for the cycling times?

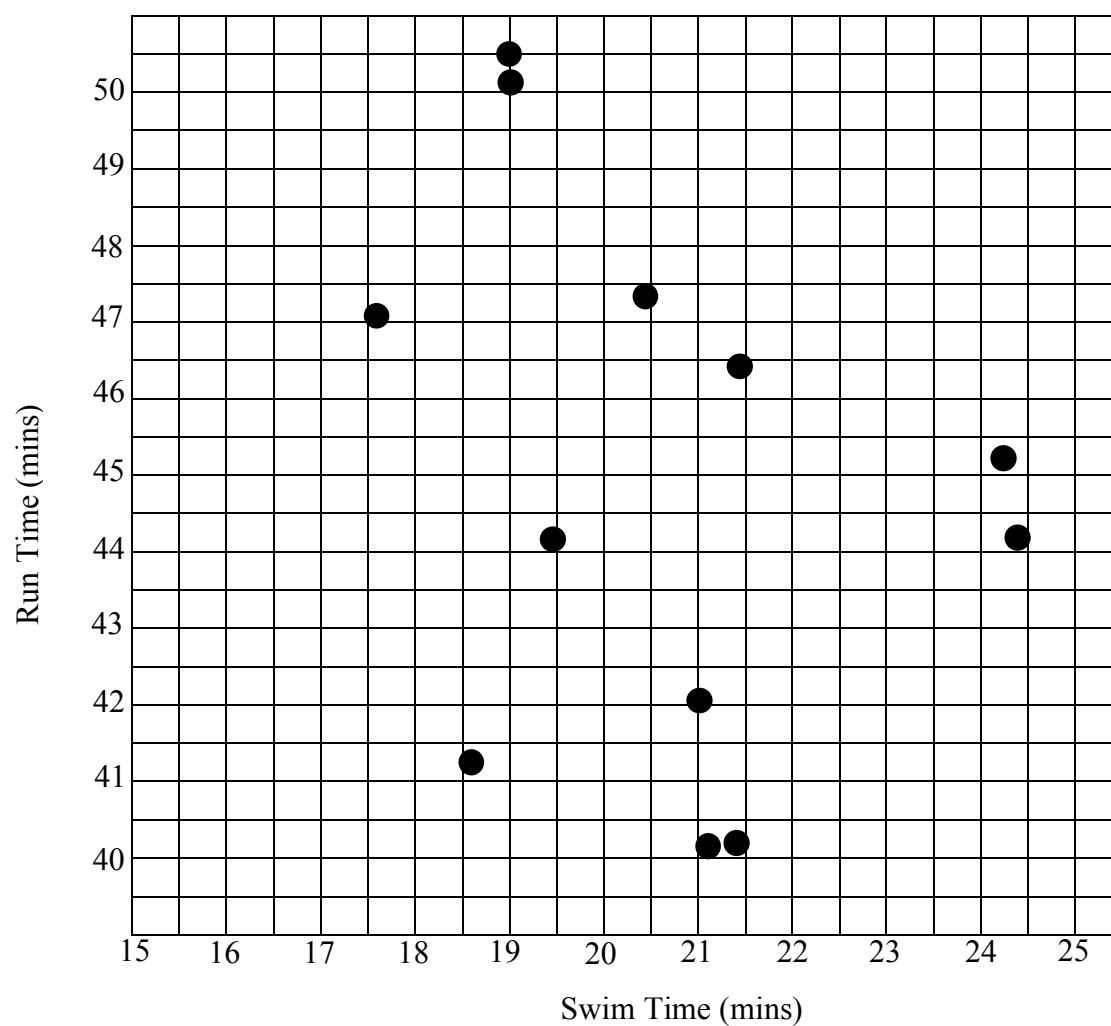
1 mark

Core: Data analysis**Question 3**

Swim	Run
19.4	44.2
17.6	47.1
18.6	41.3
21.2	40.2
21.1	42.1
19.0	50.5
24.4	44.2
21.4	40.2
19.1	50.1
21.4	46.4
20.4	47.2
24.2	45.2

The above table gives the swim and run times, in minutes, for the females.

A scatter graph of these results is drawn below.



Core: Data analysis**Question 3 (continued)**

- a.** What is the equation of the least squares regression line?
Give all values to one decimal place.

1 mark

- b.** Draw this line on the graph on the previous page

1 mark

- c.** What is the value of the correlation coefficient?
Give your answer to one decimal place.

1 mark

- d.** What can you conclude from the correlation coefficient?

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

Meg has written a book for children. On each page she has increased the number of words by the same amount. On page one she has written “The Big Dog”, on page two she has “Ben is a black dog”, and page three says, “He likes to run and catch balls”

If this pattern continues

- a.** How many words will be on page 4?

1 mark

- b.** How many words will be on page 25?

1 mark

- c.** How many words will there be altogether if the book has 30 pages?

1 mark

- d.** What is the maximum number of pages if the total number of words does not exceed 300?

1 mark

Module 1: Number patterns and applications**Question 2**

The publisher of the book works to the formula:

The number of copies of the book produced each year, B_n , equals 20% more than the number of copies produced the year before, plus 50, until the number of copies produced altogether equals 15,000.

- a. If the number of copies of the book produced in the first year was 3000, write the difference equation for the number of copies of the book produced each year.

1 mark

- b. How many copies of the book were produced in the third year of publication?

1 mark

- c. In what year will the total number of copies first exceed 10,000?

1 mark

Module 1: Number patterns and applications**Question 3**

The cost of printing 100 copies of Meg's book is \$75 a book. This price decreases by \$5 a book each time an additional 200 copies are printed, until the price reaches \$5 a copy, when the price remains constant. Hence, the cost of printing 100 copies is \$7500 and the price of printing 300 copies is \$21000

- a. What is the total cost of printing 500 copies of Meg's book?

1 mark

- b. What is the total cost of printing 2100 copies of Meg's book?

1 mark

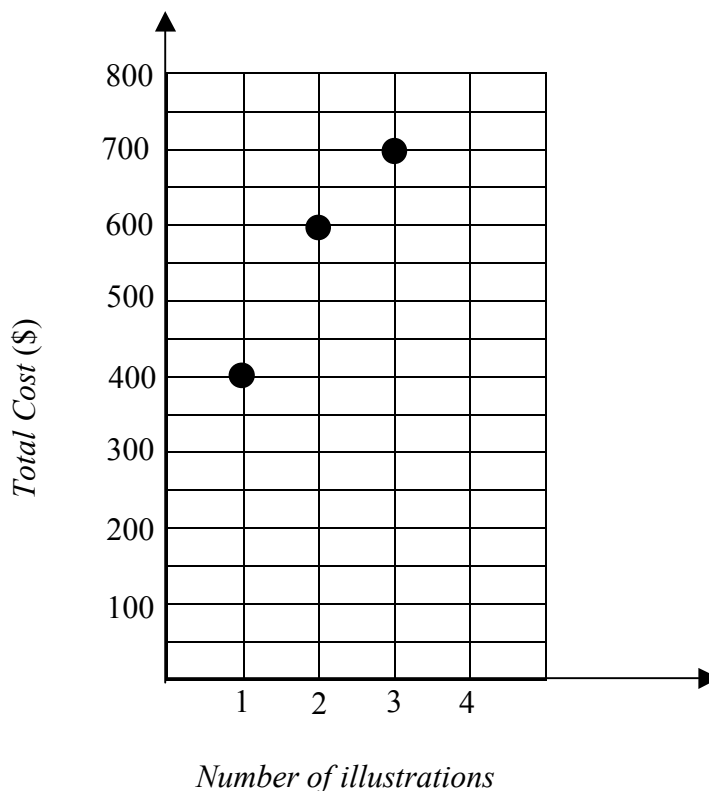
- c. What is the minimum number of books that would need to be printed to have a unit cost of \$5?

1 mark

Module 1: Number patterns and applications**Question 4**

The illustrator of the book charges \$400 for the first illustration, \$200 for the second illustration and \$100 for the third illustration.

- a. If the pattern continues in this way, show the cost of four illustrations on the graph below.



1 mark

- b. What type of sequence is generated by the charges for each successive illustration. Give a reason for your answer.

2 marks

Module 1: Number patterns and applications

Question 4 (continued)

- c. What is the total cost for seven illustrations?

1 mark

- d. What is the maximum amount charged for illustrating a book?

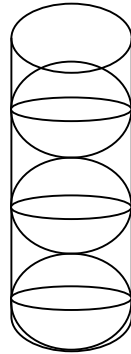
1 mark

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

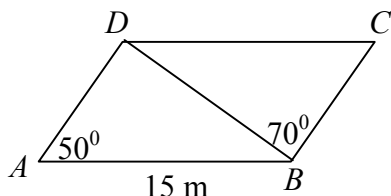
3 balls of diameter 6.8 cm are held in a cylindrical container where there is no space for the balls to move around. At least one of the balls touches the top, the bottom and the sides of the container.

- a.** What is the height of the container?

1 mark

- b.** What is the volume of the container that is occupied by air? Give your answer to 2 decimal places.

1 mark

Module 2: Geometry and trigonometry**Question 2**

The balls are used to play Super Ball on a court like the one above where $ABCD$ is a parallelogram. $AB = 15\text{ m}$ and $\angle BAD = 50^\circ$ and $\angle CBD = 70^\circ$

- a. What is the size of $\angle CBA$?

1 mark

- b. What is the length of DA ? Give your answer to 2 decimal places.

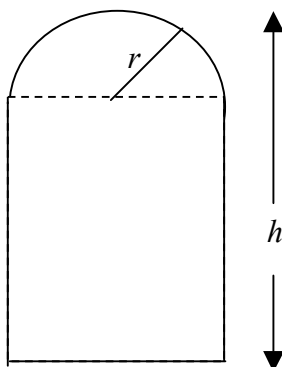
1 mark

- c. What is the length of AC ? Give your answer to the nearest metre.

1 mark

- d. What is the area of the court? Give your answer to one decimal place.

1 mark

Module 2: Geometry and trigonometry**Question 3**

The outside door to the Super Ball court is a semi circle of radius, r , which sits on top of a rectangle. The height of the rectangle is twice its width. The perimeter of the door is 10 m

- a. What is the width of the door in terms of r ?

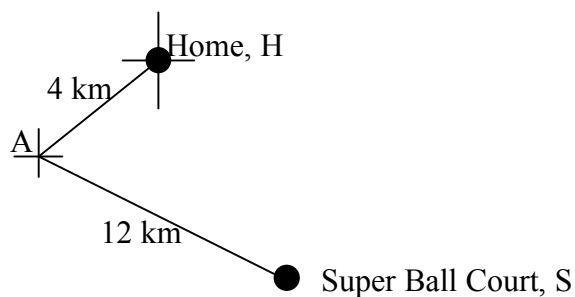
1 mark

- b. What is the actual height, h , of the door? Give your answer to one decimal place.

1 mark

- c. What is the area of the door? Give your answer to one decimal place.

1 mark

Module 2: Geometry and trigonometry**Question 4**

To reach the Super Ball court from his home, Josh must travel a distance of 4 km in a direction 205°T to point A and then travel 125°T for 12 km.

- a. What is the size of $\angle HAS$?

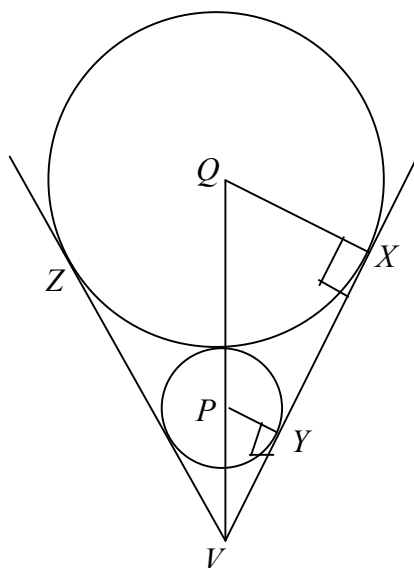
1 mark

- b. What is the direct distance, HS , from Josh's home to the Super Ball Court? Give your answer to one decimal place.

1 mark

- c. What is the bearing of Josh's home from the Super Ball Court? Give your answer to the nearest degree.

1 mark

Module 2: Geometry and trigonometry**Question 5**

One of the balls with a diameter of 6.8 cm, used in the Super Ball, and a ball a quarter of this size in diameter are placed in an inverted cone. P and Q are the centres of the balls. The balls touch the cone at Y and X . $\angle VYP = \angle VXQ = 90^\circ$.

- a. What is the length of PQ ?

1 mark

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

1 mark

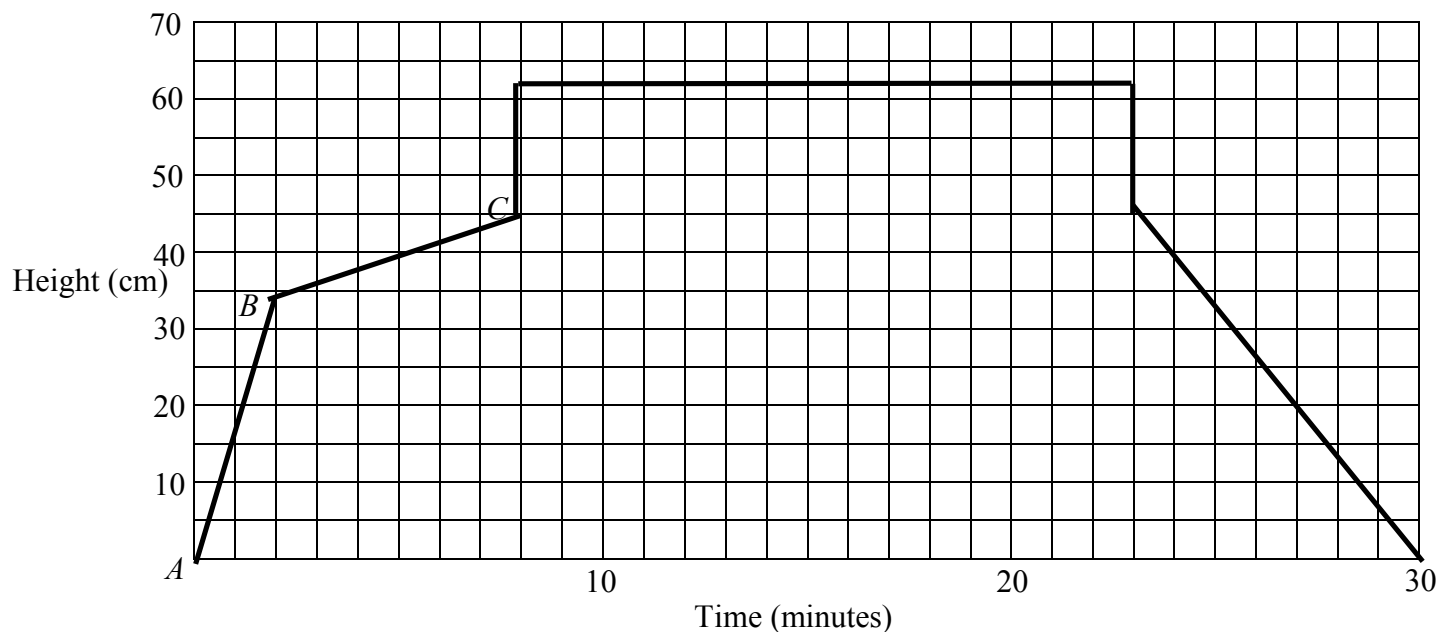
- c. What is the size of $\angle ZVX$? Give your answer to the nearest degree.

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

Martha fills a bath with water and then has a bath before emptying the water. This is shown in the above graph.

- a. What is the depth of water in the bath just as Martha is about to get into the bath?

1 mark

- b. Explain what Martha does at point B on the graph.

1 mark

Module 3: Graphs and relations**Question 1 (continued)**

- c. For how long is Martha in the bath?

1 mark

- d. If the equation of the line AB is $2h - 33t = 0$, what is the exact depth of the water at point B where $t = 2$?

1 mark

- e. What is the equation of the line BC ?

1 mark

- f. At what rate does the water empty from the bath? Give your answer to one decimal place.

1 mark

- g. If the water emptied at 9 litres per minute, how long would it take to empty the bath water?

1 mark

Module 3: Graphs and relations**Question 2**

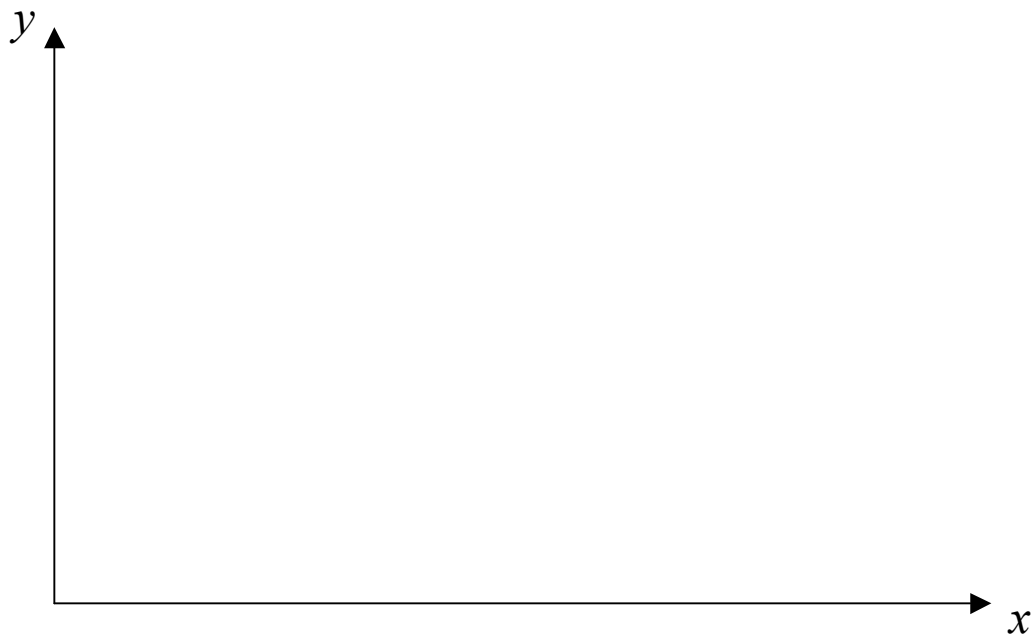
A company produces spa baths and claw foot baths. Each spa bath takes 6 hours to produce and each claw foot bath takes 3 hours to manufacture. In order to break even, the company needs to make at least 10 baths per week. The factory can operate for a maximum of 9 hours a day on 6 days a week. If the company makes x spa baths and y claw foot baths per week, then complete the following inequalities that satisfy the constraints.

a. i. $6x + 3y$

ii. $x + y$

2 marks

- b. Sketch the lines required to show the above two inequalities on the axes below.
At this stage do not shade the required region.



2 marks

Module 3: Graphs and relations**Question 2 (continued)**

- c. If at least 3 spa baths need to be made each week, shade the region on your graph that satisfies this and the other given constraints.

1 mark

- d. If the profit on each spa bath is \$300 and the profit on a claw foot bath is \$120, write down an equation for finding the profit, P , in terms of x and y .

1 mark

- e. If the company wants to maximize its profit, how many of each type of bath should it produce each week?

1 mark

- f. What is the maximum profit?

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

- a.** Peter has 3 cars for his business. After 5 years of use the total value of the cars is \$55775. If the annual depreciation is \$6845

- i.** What was the total cost price of the three cars?

1 mark

- ii.** What was the percentage rate of depreciation for the cars in the first year? Give your answer to one decimal place

1 mark

- iii.** When the total value of the cars first reaches less than \$30000, Peter sells the cars and buys new cars. How many years will he have the cars before he sells them?

1 mark

Question 2

Peter's accountant, Gemma, suggests that he should use a reducing balance depreciation of 12% per annum.

- a.** What would be the book value of the cars at the end of 5 years if Peter took Gemma's advice? Give your answer to the nearest dollar.

1 mark

Module 4: Business-related mathematics**Question 2 (continued)**

- b.** At what rate would Peter need to depreciate the cars, using a reducing balance depreciation, if he wanted them to be worth \$39934 at the end of five years? Give your answer to the nearest whole number.

1 mark

Question 3

5 years after buying the new cars, Peter finds that to buy the same cars again would cost him \$115000 in total.

- a.** What is the inflation rate for the period of the last 5 years? Give your answer to one decimal place.

1 mark

Peter sells the cars for a total of \$60000 and uses this money as a deposit to buy the same type of cars. He borrows the rest of the money to buy the cars at a reducing balance, and he agrees to pay back \$850 per month for the next 8 years.

- b. i.** How much interest does Peter pay?

1 mark

- b. ii.** What is the interest rate per annum that he is charged? Give your answer to one decimal place.

1 mark

- c.** How much will Peter owe in six years time? Give your answer to the nearest cent.

1 mark

Module 4: Business-related mathematics**Question 4**

Peter knows that he will have to spend more money in his business in 6 years time. For this reason he puts \$30000 into different accounts.

- a. \$12000 is invested at 5.2% simple interest. What is the value of this investment at the end of 6 years?

1 mark

- b. \$12000 is invested at 4.8% per annum compounding every 6 months. How much interest will Peter have earned on this investment at the end of 6 years? Give your answer to the nearest cent.

1 mark

- c. Peter invests the rest of the \$30000 at 5.0% per annum compounding monthly. He also deposits \$500 into this account just after the interest has been paid each month. What is the total value of this investment at the end of 6 years. Give your answer to the nearest cent.

1 mark

- d. What is the final value of this \$30000 investment? Give your answer to the nearest dollar.

1 mark

Module 4: Business-related mathematics**Question 4 (continued)**

- e. How much interest would Peter have received on all three investments by the end of the six years? Give your answer to the nearest dollar.

1 mark

- f. If Peter wanted the final value of his investments at the end of the 6 years to be \$100000, how much should he pay into the \$12000 investment that is compounding every six months, just after the interest has been paid? 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

Andrew, Betty, Carol, David and Elle play in a tennis round robin.

Andrew beats Carol, Betty and Elle.

Betty beats David.

Carol beats Betty.

David beats Andrew, Elle and Carol.

Elle beats Carol and Betty.

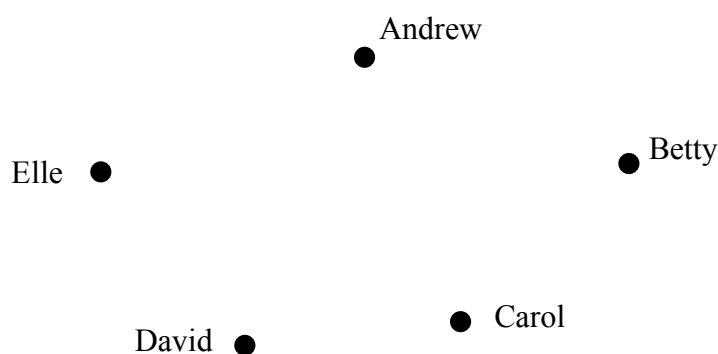
- a. If each player plays one set against every other player, how many sets does each player play?

1 mark

- b. How many sets are played altogether by the five competitors?

1 mark

- c. Join the vertices below to create a directed graph that will depict the results of the round robin.



1 mark

- d. The above graph, which connects all pairs of vertices, is called a graph.

1 mark

Module 5: Networks and decision mathematics**Question 1 (continued)**

- e. The president of the club wants to award a prize to the best player. She decides to draw up a dominance matrix to help decide who should get the prize. Complete the following dominance matrix for her.

$$\begin{array}{c} A \quad B \quad C \quad D \quad E \\ \begin{array}{c} A \\ B \\ C \\ D \\ E \end{array} \left[\begin{array}{ccccc} 0 & 1 & & 0 & \\ 0 & 0 & & 1 & \\ 0 & 1 & & 0 & \\ 1 & 0 & & 0 & \\ 0 & 1 & & 0 & \end{array} \right] \end{array}$$

2 marks

- f. The president finds that the above matrix ranks two players equal first. Who are the players?

1 mark

Module 5: Networks and decision mathematics**Question 1 (continued)**

- g.** The president has only one prize and so decides to draw up a second order dominance matrix. Complete this matrix below.

$$\begin{array}{c} A \\ B \\ C \\ D \\ E \end{array} \begin{array}{ccccc} A & B & C & D & E \\ \left[\begin{array}{ccccc} 0 & 2 & 1 & 1 & 0 \\ & & & & \\ & & & & \\ & & & & \\ 0 & 1 & 0 & 1 & 0 \end{array} \right] \end{array}$$

3 marks

- h.** Who wins the prize?

1 mark

Module 5: Networks and decision mathematics**Question 2**

Before the tennis round robin could be started, the court had to be marked, the balls had to be collected, the net had to be put up and the court had to be bagged. Elle was going to be late arriving so the other four players had to do the above four jobs. From past experience, it was known how many minutes each of these four players took to perform these tasks. The times are given in the following table.

Person	Mark Court	Bag Court	Collect Balls	Put up net
Andrew	12	8	10	8
Betty	9	12	9	8
Carol	12	10	8	8
David	12	12	14	13

a.

Draw up a reduction matrix to help you allocate the tasks so that the tasks will take the least time possible.

1 mark

Module 5: Networks and decision mathematics**Question 2 (continued)**

- b.** Allocate the jobs to the four people.

1 mark

- c.** If they all start their jobs at the same time, who will be the last to finish and how many minutes will the others have to wait for this person to finish after they have all finished?

2 marks

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

A store sells shoes for men women and children. The shoes come in three colours, black, brown and white. The following table shows the number of pairs of different coloured shoes sold in February.

	Men	Women	Children
Black	80	100	160
Brown	70	40	60
White	10	50	90

The number of pairs of shoes sold per week during this month is given in the table below.

	Men	Women	Children
Week 1	40	60	98
Week 2	60	55	70
Week 3	20	50	62
Week 4	40	25	80

The cost of a pair of shoes in any colour for men, women and children is \$240, \$120, and \$80 respectively.

- a. Complete the following matrix, N , which shows the number of different coloured pairs of shoes sold to men, women and children in February.

$$N = \begin{matrix} & \begin{matrix} \textit{Men} & \textit{Women} & \textit{Chn.} \end{matrix} \\ \begin{matrix} \textit{Black} \\ \textit{Brown} \\ \textit{White} \end{matrix} & \left[\begin{array}{ccc} & & \\ & & \\ & & \end{array} \right] \end{matrix}$$

1 mark

Module 6: Matrices**Question 1 (continued)**

- b. Write a 3×4 matrix, M , that shows the number of shoes sold each week during the month of February for men, women and children.

$$M = \begin{bmatrix} & & & \\ & & & \\ & & & \end{bmatrix}$$

1 mark

- c. Write a column matrix, C , that shows the cost of a pair of shoes for the different categories of people.

$$C = \begin{bmatrix} \\ \\ \end{bmatrix}$$

1 mark

Module 6: Matrices**Question 1 (continued)**

- d. Find matrix X , where $X = NC$

1 mark

- e. Explain the significance of each of the elements in matrix X .

1 mark

In March it is expected that the number of each type of shoe sold per week will be five times what it was in February, because of a 25% reduction in the cost of each type of shoe for the month of March.

- f. Write down a matrix that shows the cost of men's women's and children's shoes for the month of March.

$$\begin{bmatrix} & & \\ & & \\ & & \end{bmatrix}$$

1 mark

Module 6: Matrices**Question 1 (continued)**

- g.** Write down the matrices and the arithmetic process you would use to find the amount of money expected to be taken each week in March, and find these amounts.

2 marks

- h.** If the expectations for March are correct, which of the two months will provide the greater takings and by how much?

1 mark

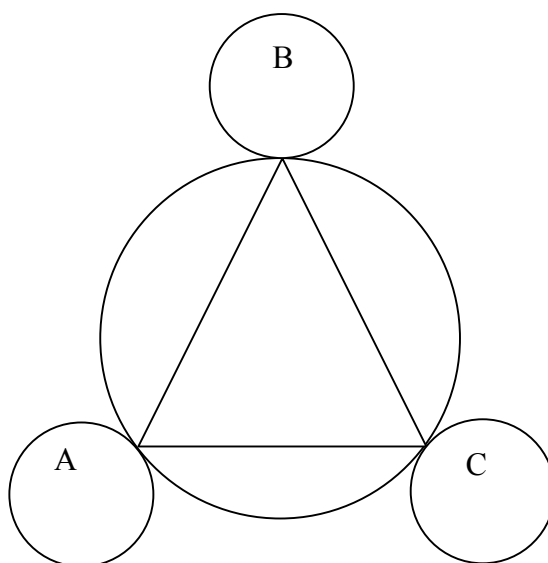
Module 6: Matrices**Question 2**

Best Car auto rental is setting up three rental locations and will allow car renters to return their rented cars to any of their locations. The following matrix shows the proportion of cars Best Car expects will be rented from and returned to each of the three sites.

		Site returned to		
		<i>A</i>	<i>B</i>	<i>C</i>
Site returned from	<i>A</i>	0.6	0.1	0.3
	<i>B</i>	0.4	0.5	0.1
	<i>C</i>	0.3	0.4	0.3

They expect 600, 300 and 400 rentals per month from sites A, B and C respectively, and so plan to begin on 1st. January 2012 with this number of cars at each site.

- a. Using the information in the above matrix, complete the following diagram, showing the percentage of cars rented from and returned to each site. Include arrows in your diagram to show the direction of movement.



1 mark

Module 6: Matrices**Question 2 (continued)**

- b.** How many cars do they expect will be returned to the site from which they were rented?

1 mark

- c.** Showing the matrices you would use, how many cars would you expect at each of the three sites on 1st. February, 2012?

2 marks

Module 6: Matrices**Question 2 (continued)**

- d. Which site will not have sufficient cars to meet the demand on 1st.February, 2012?

1 mark

- e. In the long run, how many cars would you expect to be returned to site A?

1 mark

Total = 15 marks

End of Module 6: Matrices

END OF QUESTION AND ANSWER BOOK
2012 Further Mathematics Trial Examination 2

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