THE HEFFERNAN GROUP
P.O. Box 1180
Surrey Hills North VIC 3127
Phone 03 9836 5021
Fax 03 9836 5025
info@theheffernangroup.com.au
www.theheffernangroup.com.au

Student Name……………………………………

FURTHER MATHEMATICS

TRIAL EXAMINATION 1

2018

Reading Time: 15 minutes
Writing time: 1 hour 30 minutes

Instructions to students

This exam consists of Section A and Section B.
Section A contains 24 multiple-choice questions from the core.
Section A is compulsory and is worth 24 marks.
Section B begins on page 13 and consists of 4 modules each containing 8 multiple-choice questions. You should choose 2 of these modules and answer every question in each of your chosen modules. Each of the modules is worth 8 marks.
Section B is worth 16 marks.
There are a total of 40 marks available for this exam.
Students may bring one bound reference into the exam.
Students may bring into the exam one approved technology (calculator or software) and, if desired, one scientific calculator. Calculator memory does not need to be cleared. For approved computer-based CAS, full functionality may be used.
Unless otherwise stated, the diagrams in this exam are not drawn to scale.
Formula sheets can be found on pages 30 and 31 of this exam.
An answer sheet appears on page 32 of this exam.

This paper has been prepared independently of the Victorian Curriculum and Assessment Authority to provide additional exam preparation for students. Although references have been reproduced with permission of the Victorian Curriculum and Assessment Authority, the publication is in no way connected with or endorsed by the Victorian Curriculum and Assessment Authority.

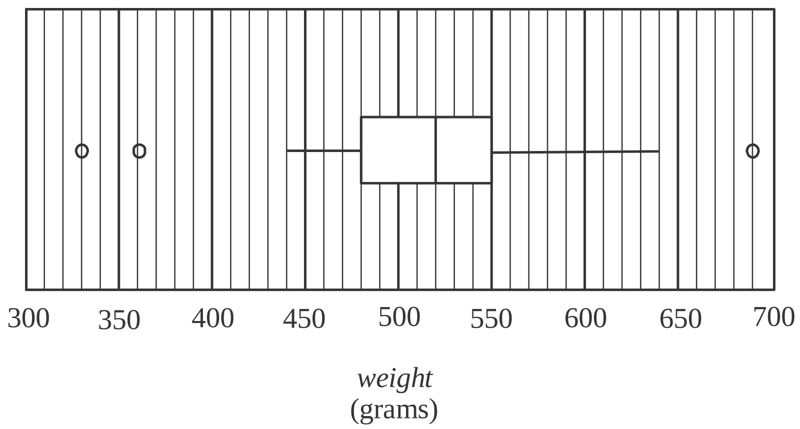
SECTION A - Core

Data analysis

This section is compulsory.

Question 1

The boxplot below shows the distribution of the *weight*, in grams, of fish caught off a pier.



The range is

A. 70
B. 110
C. 200
D. 250
E. 360

Question 2

A sample of eight students at a school were selected and the distance, in kilometres, that they travelled to school was recorded. The data is shown in the table below.

Distance	2.1	1.3	1.8	0.9	1.7	1.4	1.3	2.3

For this sample of students, the mean $\bar{x}$, and the standard deviation s_x, of the distance they travelled to school is closest to

A. $\bar{x} = 0.43 \quad s_x = 1.6$
B. $\bar{x} = 0.44 \quad s_x = 1.6$
C. $\bar{x} = 1.6 \quad s_x = 0.43$
D. $\bar{x} = 1.6 \quad s_x = 0.46$
E. $\bar{x} = 1.6 \quad s_x = 0.47$

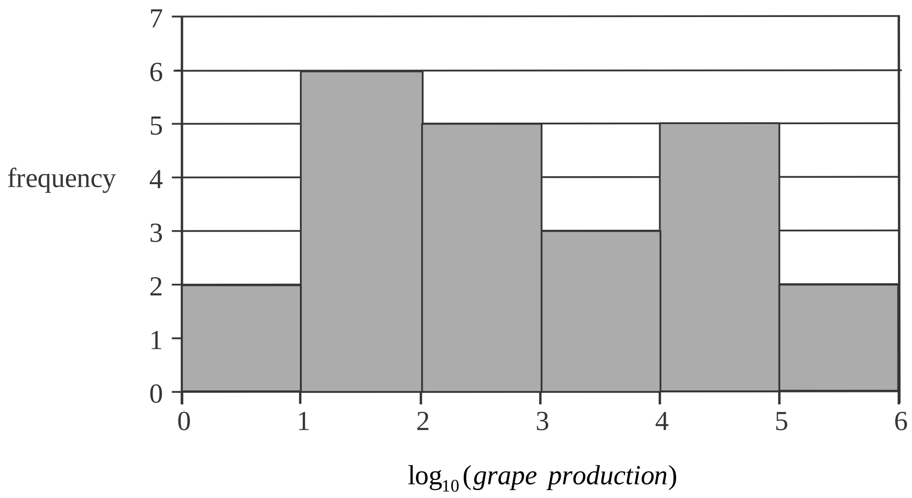
Question 3

At a large sports stadium the time spent by patrons waiting to gain entry is approximately normally distributed with a mean of 4.6 minutes and a standard deviation of 0.8 minutes. Next weekend it is expected that 28 000 patrons will attend the stadium.
The number of these patrons who are expected to wait between 3 and 6.2 minutes is

A. 9 520
B. 13 300
C. 17 080
D. 19 040
E. 26 600

Question 4

The histogram below shows the distribution of the $\log_{10}$ (*grape production*), where grape production is measured in tons, for 23 commercial and hobby wine producers.

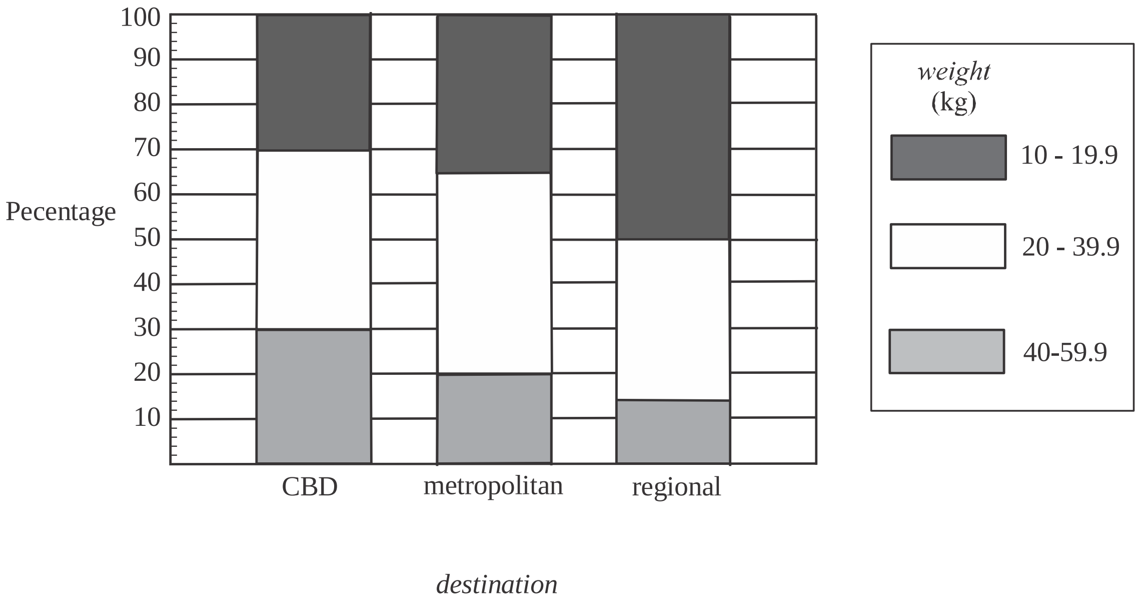


The median grape production, in tons, for these producers is between

A. 1 and 2
B. 2 and 3
C. 3 and 4
D. 100 and 1 000
E. 1 000 and 10 000

Use the following information to answer Questions 5 and 6.

At a distribution warehouse packages are sorted by their *destination* (CBD, metropolitan, regional) and *weight* (10 - 19.9kg, 20 - 39.9kg, 40 - 59.9kg).
The percentage segmented bar chart below summarises the packages that were sorted in 2017.



Question 5

The variables *destination* (CBD, metropolitan and regional) and *weight* (10 - 19.9kg, 20 - 39.9kg, 40 - 59.9kg) are

A. a categorical variable and a numerical variable respectively
B. both ordinal variables
C. an ordinal variable and a nominal variable respectively
D. both nominal variables
E. a nominal variable and an ordinal variable respectively.

Question 6

The percentage segmented bar chart suggests that there is an association between the variables *weight* and *destination*.
This could be shown by the fact that

A. 30% of packages with a CBD destination weighed 10 - 19.9kg and 50% with a regional destination weighed 10 - 19.9kg.
B. 50% of packages with a regional destination weighed 10 - 19.9kg.
C. 40% of packages with a CBD destination weighed 20 - 39.9kg and 50% of packages with a regional destination weighed 10 - 19.9kg.
D. the percentage of packages with a regional destination and a weight of 10 - 19.9kg is greater than those with a regional destination and a weight of 40 - 59.9kg.
E. the majority of packages with a metropolitan destination had a weight of 20 - 39.9kg.

Question 7

The association between a person's weight, in kilograms, and their place of residence (city or regional) is being investigated.
An appropriate graphical tool to use would be

A. a scatterplot
B. a parallel box plot
C. an ordered stem plot
D. a dot plot
E. a histogram

Question 8

The number of attempts required (one, two or three) to obtain a driver's licence for female and male siblings was recorded for 68 pairs of siblings. The results are displayed in the frequency table below.

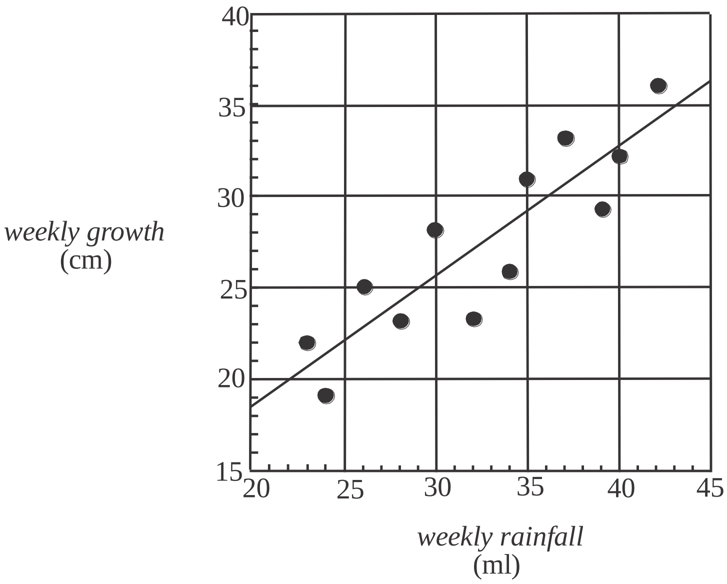
		Female sibling		
		one attempt	two attempts	three attempts
Male sibling	one attempt	19	8	4
	two attempts	14	10	3
	three attempts	3	5	2

Of the female siblings who took two attempts to obtain their drivers licence, the percentage who have a male sibling who took three attempts is closest to

A. 7%
B. 15%
C. 22%
D. 34%
E. 40%

Use the following information to answer Questions 9 and 10.

The scatterplot below shows the *weekly growth*, in centimetres, and the *weekly rainfall* received, in millimetres for a crop planted in 12 tropical locations.



A least squares line has been fitted to the scatterplot with *weekly rainfall* as the explanatory variable.

Question 9

The intercept of the least squares line tells us that on average when weekly rainfall is zero the weekly growth, in cm, will be closest to

A. 0
B. 0.7
C. 4.5
D. 18.5
E. 20

Question 10

The least squares line shown on the scatterplot is used to predict the weekly growth of the crop which is grown at the location with a weekly rainfall of 32ml.
The residual is closest to

A. – 4
B. – 1
C. 1
D. 4
E. 7

Question 11

A large study of office workers shows that there is a negative correlation between the weight of the office workers and the time they spend at a stand up desk each day. The correlation coefficient is $r = -0.8$.

From this it can be concluded that

A. 80% of office workers who have a stand up desk lose weight.
B. the slope of the least squares line is -0.8.
C. office workers who tend to spend more time at a stand up desk each day tend to weigh less.
D. 64% of office workers who switched to a stand up desk lost weight.
E. 20% of workers who spent increased time at stand up desks each day did not lose weight.

Question 12

A study of elderly patients is undertaken and the association between the two variables *age*, in years, and *weight*, in kilograms, is found to be non-linear.

A reciprocal transformation to the variable *weight* is performed and the equation of the least squares regression line for this transformed data is found to be

$$\frac{1}{weight} = -0.002 + 0.0002 \times age.$$

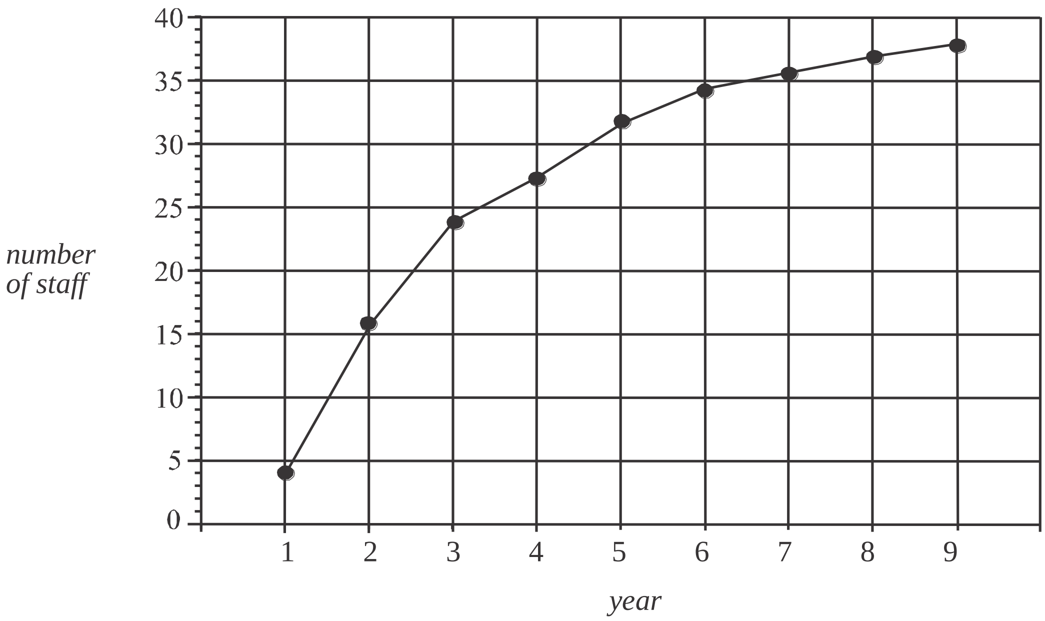
This least squares line predicts that the $\frac{1}{weight}$ of an elderly patient of age 90 years will be 0.016.

The weight, in kilograms, of a 90 year old patient is therefore expected to be

A. 56.25
B. 62.5
C. 67.75
D. 71.25
E. 75.5

Question 13

The time series plot below shows the number of staff employed by a business during the first nine years of its operation.



The data used to generate this plot is displayed in the table below.

year	1	2	3	4	5	6	7	8	9
number of staff	4	16	24	27	32	34	36	37	38

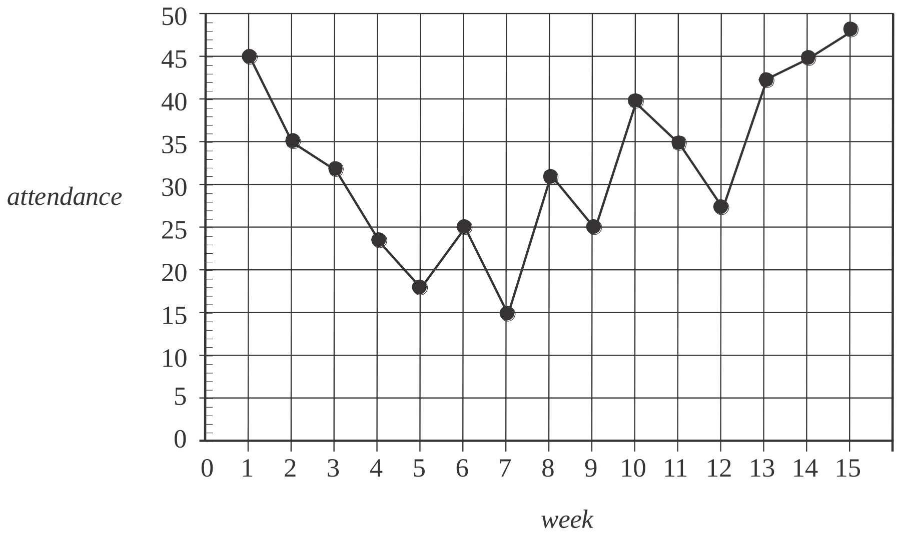
The association between the *number of staff* employed and the *year* of operation is non-linear. A $\log_{10}$ transformation is applied to the variable *year* in an attempt to linearise the data.

The resulting equation of the least squares regression line that can be used to predict the *number of staff* from $\log_{10}(year)$ is closest to

A. $number\ of\ staff = 5.2 + 36 \times \log_{10}(year)$
B. $\log_{10}(number\ of\ staff) = 5.2 + 36 \times year$
C. $number\ of\ staff = -0.1 + 0.03 \times \log_{10}(year)$
D. $\log_{10}(number\ of\ staff) = -0.1 + 0.03 \times year$
E. $number\ of\ staff = 0.9 + 27 \times \log_{10}(year)$

Question 14

The time series plot below shows the *attendance* at a weekly lecture over a 15 week period.



The seven-median smoothed *attendance* for week 12 is closest to

A. 25
B. 35
C. 40
D. 42
E. 45

Question 15

The seasonal index for sales at a pool shop in winter is 0.8. To correct for seasonality, the actual sales in winter should be

A. increased by 20%
B. decreased by 20%
C. increased by 25%
D. decreased by 25%
E. increased by 40%

Question 16

The daily seasonal index for six days of the week for turnover at a café is shown in the table below.

Day	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.	Sun.
Seasonal index	0.95	0.87	0.73		1.24	1.17	1.21

The daily seasonal index for Thursday has been omitted. Last Thursday the actual turnover for the café was \$3 820.
The deseasonalised value of this turnover was closest to

A. \$3 088
B. \$3 171
C. \$3 737
D. \$4 327
E. \$4 602

Recursion and financial modelling

Question 17

The first five terms of a sequence are $-1, 0, 4, 20, 84, \ldots$
The recurrence relation that generates this sequence is

A. $A_0 = -1, \quad A_{n+1} = A_n + 1$
B. $A_0 = -1, \quad A_{n+1} = 2A_n + 2$
C. $A_0 = -1, \quad A_{n+1} = 3A_n + 3$
D. $A_0 = -1, \quad A_{n+1} = 4A_n + 4$
E. $A_0 = -1, \quad A_{n+1} = 5A_n + 5$

Question 18

A coffee machine was purchased by a café owner for $42 500. Each year, on average, the coffee machine produces 90 000 servings of coffee. The value of the machine is depreciated using a unit cost method of depreciation and three years after its purchase, the value of the coffee machine is $9 600.
The depreciation in the value of the coffee machine, per serving of coffee produced, is closest to

A. 2 cents
B. 12 cents
C. 18 cents
D. 37 cents
E. 47 cents

Question 19

Daniel invests $12 000 in an account that earns interest of 4.6% per annum compounding quarterly.
Let V_n be the value of the investment after *n* quarters.
A recurrence relation that can be used to model Daniel's investment is

A. $V_0 = 12\,000, \quad V_{n+1} = 0.0115V_n$
B. $V_0 = 12\,000, \quad V_{n+1} = 0.46V_n$
C. $V_0 = 12\,000, \quad V_{n+1} = 1.0115V_n$
D. $V_0 = 12\,000, \quad V_{n+1} = 1.15V_n$
E. $V_0 = 12\,000, \quad V_{n+1} = 1.46V_n$

Question 20

Nicole takes out a five year, interest only business loan of $120 000. Interest is charged at 4.8% per annum compounding monthly. Nicole pays only the interest on the loan each month.
The amount Nicole owes at the end of five years is

A. $93 835
B. $117 619
C. $120 000
D. $122 419
E. $151 701

Question 21

Maha borrows $25 000 at an interest rate of 7.8% per annum, calculated six monthly. Maha plans to repay the loan in six monthly instalments, after interest is calculated, over 6 years. The effective annual interest rate that Maha will be paying on this loan is closest to

A. 3.9%
B. 7.8%
C. 7.95%
D. 15.6%
E. 33.6%

Question 22

The last four lines of an amortisation table for a reducing balance loan are shown below. The interest rate throughout the loan is constant. The final payment may differ from previous payments.

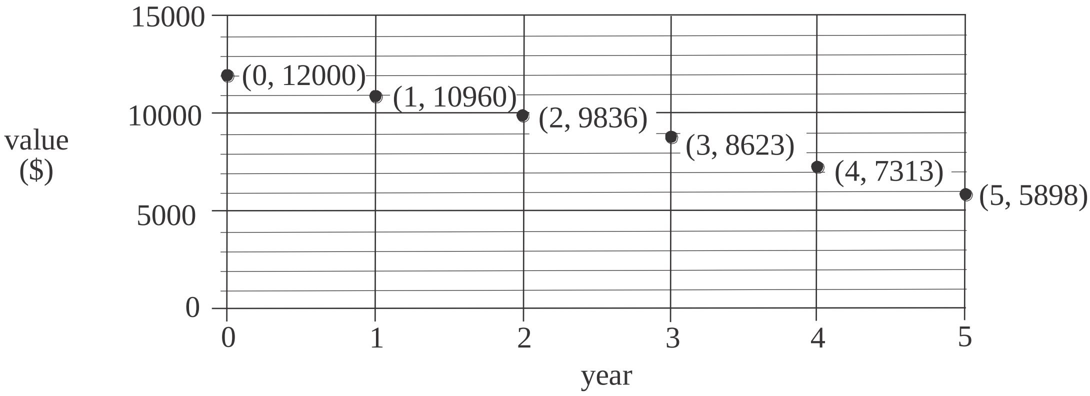
The balance of the loan after payment number 10 is $0.

Payment number	**Payment**	**Interest**	**Principal reduction**	**Balance of investment**
7	2 600	455.85	2 144.15	6 972.79
8	2 600	348.64	2 251.36	4 721.43
9	2 600	236.07	2 363.93	2 357.50
10				0.00

The value of payment number 10 is closest to

A. $2 240
B. $2 475
C. $2 600
D. $2 718
E. $2 843

Question 23



The graph above could show the value of

A. a truck depreciating at the flat rate of 8% per annum
B. an annuity with annual payments of $2 000 made to the investor and an interest rate of 8% per annum
C. a caravan depreciated using the reducing balance method at 8% per annum
D. a perpetuity attracting interest of 8% per annum
E. a reducing balance loan with annual repayments of $1 000 made by the borrower to the bank and interest rate of 8% per annum.

Question 24

Julian borrows $360 000 to purchase a business. He will fully repay the loan after 15 years. During the first seven years of this reducing balance loan the interest is 5.15% per annum compounding monthly and Julian makes monthly repayments.
During the last eight years of the loan the interest rate is 5.4% per annum compounding monthly and Julian makes monthly repayments of $2 900.

During the first seven years of the loan, Julian's monthly repayments were closest to

A. $2 877
B. $2 922
C. $2 940
D. $6 331
E. $7 373

SECTION B - Modules

Module 1: Matrices

If you choose this module all questions must be answered.

Question 1

Which of the following is a permutation matrix?

A. $\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 0 \end{bmatrix}$

B. $\begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 0 & 0 & 0 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{bmatrix}$

D. $\begin{bmatrix} 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix}$

E. $\begin{bmatrix} 0 & 1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 2 \end{bmatrix}$

Question 2

Joe operates two burger vans. Matrix M below shows the sales, in dollars, at each of these two vans over a four day period.

$$M = \begin{array}{c} \begin{matrix} van\,1 & van\,2 \end{matrix} \\ \begin{bmatrix} 870 & 840 \\ 1\,580 & 1\,790 \\ 2\,340 & 2\,560 \\ 910 & 870 \end{bmatrix} \end{array} \begin{matrix} Thurs \\ Fri \\ Sat \\ Sun \end{matrix}$$

The matrix product $H \times M$ gives the total sales at van 1 and at van 2 over this four day period. Matrix H is

A. $\begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix}$

B. $\begin{bmatrix} 1 & 0 \\ 0 & 1 \\ 1 & 0 \\ 0 & 1 \end{bmatrix}$

C. $\begin{bmatrix} 1 & 1 & 1 & 1 \end{bmatrix}$

D. $\begin{bmatrix} 1 & 0 & 1 & 0 \end{bmatrix}$

E. $\begin{bmatrix} 1 \\ 0 \\ 1 \\ 0 \end{bmatrix}$

Question 3

Consider the following four matrix equations.

$$\begin{bmatrix} 4 & 2 \\ 8 & 4 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3 \\ 7 \end{bmatrix} \qquad \begin{bmatrix} 6 & -3 \\ 4 & -2 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ 5 \end{bmatrix}$$

$$\begin{bmatrix} 0 & 0 \\ -1 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 1 \\ 2 \end{bmatrix} \qquad \begin{bmatrix} -2 & -1 \\ 2 & 1 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -3 \\ 1 \end{bmatrix}$$

The number of these matrix equations that has a unique solution is

A. 0
B. 1
C. 2
D. 3
E. 4

Question 4

Consider the matrix equation

$$\begin{bmatrix} 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 \end{bmatrix} \times R = \begin{bmatrix} T \\ E \\ A \\ M \\ S \end{bmatrix}$$

Matrix R is

A. $\begin{bmatrix} A \\ M \\ E \\ T \\ S \end{bmatrix}$

B. $\begin{bmatrix} M \\ A \\ T \\ E \\ S \end{bmatrix}$

C. $\begin{bmatrix} A \\ M \\ T \\ E \\ S \end{bmatrix}$

D. $\begin{bmatrix} S \\ E \\ T \\ A \\ M \end{bmatrix}$

E. $\begin{bmatrix} T \\ A \\ M \\ E \\ S \end{bmatrix}$

Question 5

For the matrix A, the element in row i and column j is a_{ij} where $a_{ij} = 3i - j$.

If $A - B = \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix}$, then matrix B is

A. $\begin{bmatrix} 3 & 2 & 1 \\ 6 & 5 & 2 \end{bmatrix}$

B. $\begin{bmatrix} 2 & 1 & 0 \\ 5 & 4 & 3 \end{bmatrix}$

C. $\begin{bmatrix} 1 & 0 & 1 \\ 4 & 3 & 2 \end{bmatrix}$

D. $\begin{bmatrix} 2 & 1 \\ 0 & 5 \\ 4 & 3 \end{bmatrix}$

E. $\begin{bmatrix} 1 & 0 & -1 \\ 4 & 3 & 2 \end{bmatrix}$

Question 6

Four students Andrew, (A), Brent (B), Chris (C) and Danica (D) competed in a chess competition. Each of these four students played each of the other students once, and there were no draws.
The results are shown in the matrix below.

$$\begin{array}{cc} & \textit{loser} \\ & \begin{array}{cccc} A & B & C & D \end{array} \\ \textit{winner} \begin{array}{c} A \\ B \\ C \\ D \end{array} & \begin{bmatrix} 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 & 1 & 0 & 0 \end{bmatrix} \end{array}$$

A ‘1’ in the matrix indicates that the student in that particular row defeated the student in that particular column. Each student was ranked according to the sum of their one-step and two-step dominances.
The ranking of the students, from first to last, is given respectively by

A. Andrew, Chris. Brent, Danica
B. Chris, Andrew, Brent, Danica
C. Chris, Danica, Andrew, Brent
D. Danica, Andrew, Chris, Brent
E. Danica, Andrew, Brent, Chris.

Question 7

For the matrix recurrence relation $S_0 = \begin{bmatrix} a \\ 5 \\ 20 \end{bmatrix}$, $S_{n+1} = T\,S_n$,

$S_1 = \begin{bmatrix} 16 \\ b \\ c \end{bmatrix}$ where a, b and c are constants and the transition matrix $T = \begin{bmatrix} 0.1 & 0.5 & 0.6 \\ 0.4 & 0.2 & 0.3 \\ 0.5 & 0.3 & 0.1 \end{bmatrix}$.

Which one of the following expressions is true?

A. $a < b$
B. $a > c$
C. $a = b + c$
D. $a + b + c = 1$
E. $a > b + c$

Question 8

For employees in a large hospitality organisation,

- probationary staff (P) can eventually become general staff (G) or they can leave (L)
- general staff (G) can eventually become managers (M) or they can leave (L)
- managers (M) will eventually leave (L).

The matrix E_0 below shows the initial state matrix for employee numbers at the organisation.

$$E_0 = \begin{bmatrix} 160 \\ 700 \\ 40 \\ 0 \end{bmatrix} \begin{matrix} P \\ G \\ M \\ L \end{matrix}$$

The number of probationary staff, general staff and managers is to be kept constant which means that each month new employees in each of the categories may be added to the organisation and existing employees may be asked to leave.
The number of employees working in the organisation after n months, E_n can be found using the rule

$$E_{n+1} = \begin{bmatrix} 0.75 & 0 & 0 & 0 \\ 0.20 & 0.80 & 0 & 0 \\ 0 & 0.01 & 0.90 & 0 \\ 0.05 & 0.19 & 0.10 & 1 \end{bmatrix} E_n + F$$

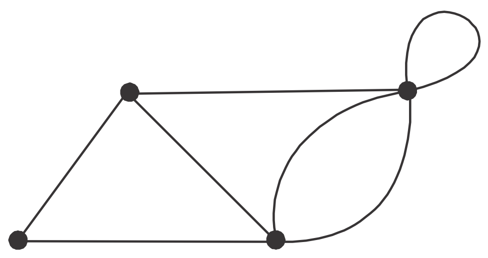
where F is a column matrix giving the number of probationary staff, general staff and managers who are added to the organisation or are asked to leave the organisation each month as well as the number of employees who decide themselves to leave the organisation.
It follows that each month the organisation will

A. ask 40 probationary staff to leave
B. add 40 general staff
C. ask 108 general staff to leave
D. add 145 probationary staff
E. ask 3 managers to leave.

Module 2: Networks and decision mathematics

If you choose this module all questions must be answered.

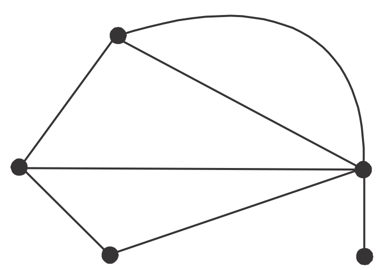
Question 1



The sum of the degrees of all the vertices shown in the graph above is

A. 7
B. 10
C. 12
D. 13
E. 14

Question 2

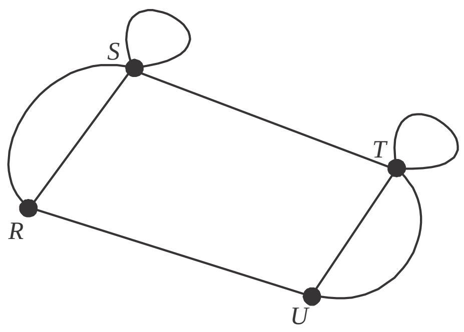


For the graph shown above, it is possible to find

A. an Eulerian trail
B. an Eulerian circuit
C. a Hamiltonian path
D. a Hamiltonian cycle
E. a minimum spanning tree.

Question 3

Consider the following graph.



An adjacency matrix that could represent this graph is

A. $\begin{array}{c} \\ R \\ S \\ T \\ U \end{array}\begin{array}{c} \begin{matrix} R & S & T & U \end{matrix} \\ \begin{bmatrix} 0 & 2 & 0 & 1 \\ 2 & 1 & 1 & 0 \\ 0 & 1 & 1 & 2 \\ 1 & 0 & 2 & 0 \end{bmatrix} \end{array}$

B. $\begin{array}{c} \\ R \\ S \\ T \\ U \end{array}\begin{array}{c} \begin{matrix} R & S & T & U \end{matrix} \\ \begin{bmatrix} 0 & 2 & 0 & 1 \\ 2 & 0 & 1 & 0 \\ 0 & 1 & 0 & 2 \\ 1 & 0 & 2 & 0 \end{bmatrix} \end{array}$

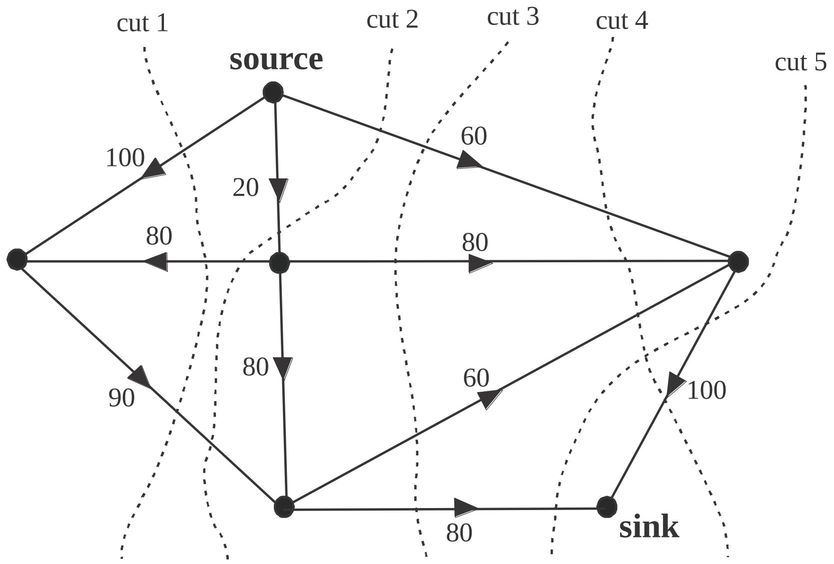
C. $\begin{array}{c} \\ R \\ S \\ T \\ U \end{array}\begin{array}{c} \begin{matrix} R & S & T & U \end{matrix} \\ \begin{bmatrix} 1 & 0 & 2 & 1 \\ 0 & 1 & 1 & 2 \\ 2 & 1 & 1 & 0 \\ 1 & 2 & 0 & 1 \end{bmatrix} \end{array}$

D. $\begin{array}{c} \\ R \\ S \\ T \\ U \end{array}\begin{array}{c} \begin{matrix} R & S & T & U \end{matrix} \\ \begin{bmatrix} 0 & 2 & 0 & 1 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 2 \\ 0 & 0 & 0 & 0 \end{bmatrix} \end{array}$

E. $\begin{array}{c} \\ R \\ S \\ T \\ U \end{array}\begin{array}{c} \begin{matrix} R & S & T & U \end{matrix} \\ \begin{bmatrix} 0 & 0 & 0 & 0 \\ 2 & 1 & 0 & 0 \\ 0 & 1 & 1 & 0 \\ 1 & 0 & 2 & 0 \end{bmatrix} \end{array}$

Question 4

The directed graph below shows the flow of a liquid, in litres per hour, through a system of tubes connecting the source to the sink

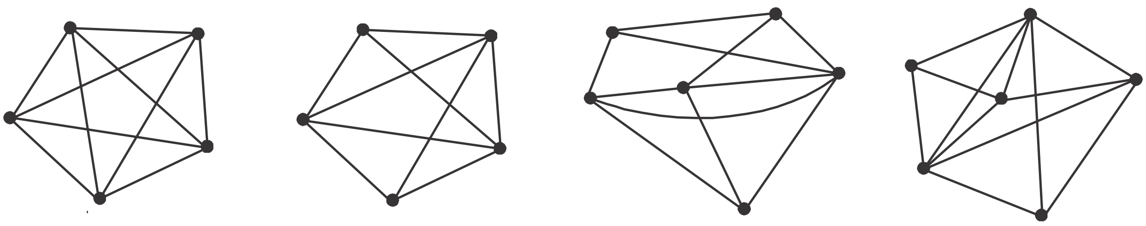


Five cuts are drawn on the diagram and one of them is the minimum cut for this network. The maximum flow of liquid, in litres per hour, that can flow from the source to the sink is

A. 90
B. 170
C. 180
D. 200
E. 280

Question 5

Consider the following four graphs.



The number of these graphs that are planar is

A. 0
B. 1
C. 2
D. 3
E. 4

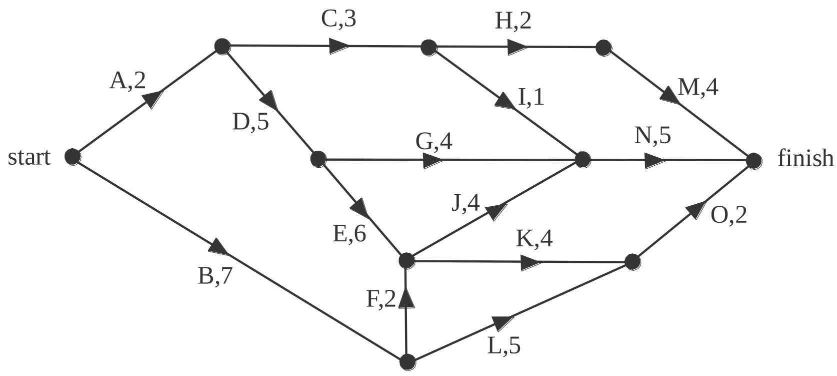
Question 6

A graph has five vertices and one bridge.
Which one of the following statements about this graph is **not** true?

A. The graph must be connected.
B. The graph must have a minimum of five edges.
C. The graph must contain at least one cycle.
D. The graph is complete.
E. The graph cannot be a tree.

Use the following information to answer Questions 7 and 8.

The directed graph below shows the sequence of activities required to complete a project and the time, in days, required to complete each activity.



Question 7

The minimum time, in days, required to complete the project is

A. 11
B. 14
C. 16
D. 18
E. 22

Question 8

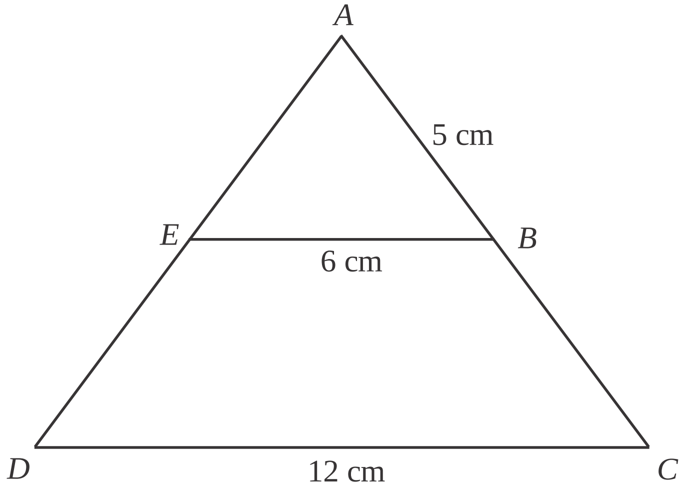
The number of activities that have a float time of 11 days is

A. 0
B. 1
C. 2
D. 3
E. 4

Module 3: Geometry and measurement

If you choose this module all questions must be answered.

Question 1

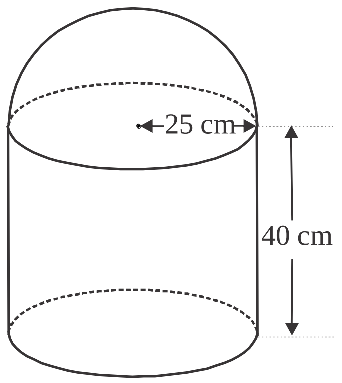


Triangle *ABE* is similar to triangle *ACD*.
Also, $BE = 6\,\text{cm}$, $CD = 12\,\text{cm}$ and $AB = 5\,\text{cm}$.
The length of *BC*, in centimetres, is

A. 5
B. 6
C. 6.8
D. 7.2
E. 10

Question 2

A vacuum cleaner canister in the shape of a cylinder with a hemisphere on top, is shown in the diagram below.



The volume of the canister, in cubic centimetres, is closest to

A. 32 725
B. 78 540
C. 111 265
D. 143 990
E. 212 581

Question 3

Four cities, together with their locations, are listed below.

Hobart (43°S, 147°E)	San Sebastian (43°N, 2°W)
Trelew (43°S, 65°W)	Vladivostok (43°N, 132°E)

On any given day, the order in which the sun will set in these cities, from first to last, is

A. San Sebastian, Trelew, Vladivostok, Hobart
B. Hobart, Vladivostok, San Sebastian, Trelew
C. San Sebastian, Trelew, Hobart, Vladivostok
D. Trelew, San Sebastian, Hobart, Vladivostok
E. Hobart, Vladivostok, Trelew, San Sebastian.

Question 4

In triangle PQR,

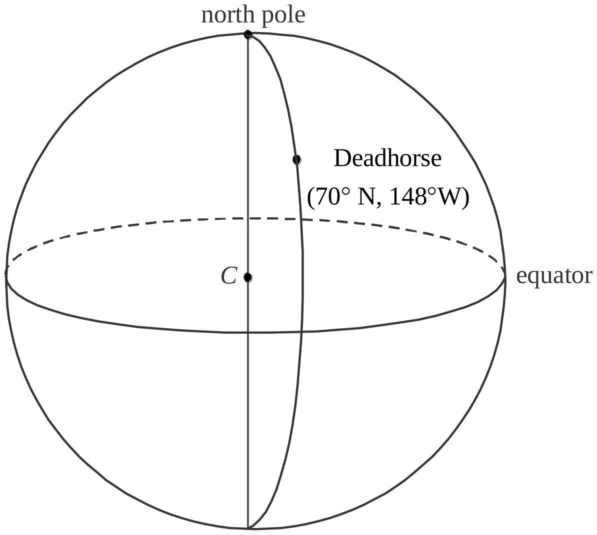
- side PQ has length 5cm
- angle PQR has magnitude 31°
- side PR has length 3cm

In triangle PQR, one of the angles, correct to the nearest degree, could be

A. 18°
B. 28°
C. 62°
D. 102°
E. 162°

Question 5

The location of the city of Deadhorse (70°N, 148°W) in Alaska, is shown on the diagram below where the point *C* indicates the centre of the sphere representing Earth. Assume that the radius of the Earth is 6 400 km.

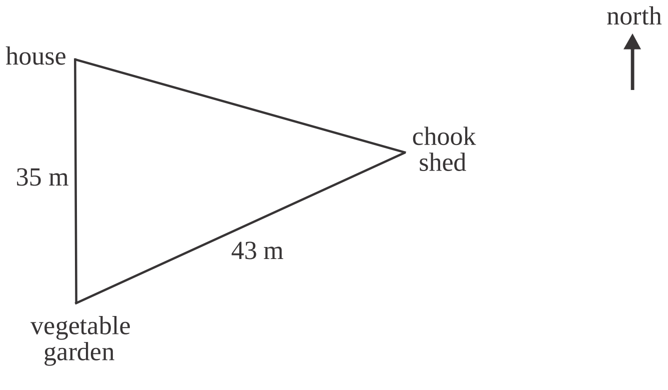


The great circle distance, in kilometres, from the city of Deadhorse to the north pole is closest to

A. 2 234
B. 3 574
C. 7 819
D. 12 287
E. 16 532

Question 6

Moni leaves her house and walks due south for 35 metres to her vegetable garden.
She then walks for 43 metres on a bearing of 062° to her chook shed before walking in a straight line back to her house.

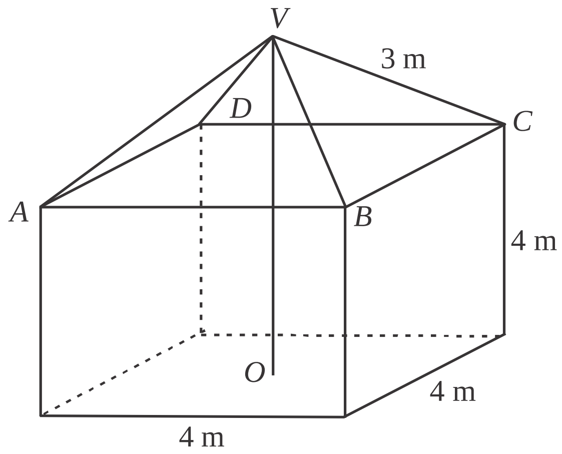


The straight line distance, in metres, from the chook shed to Moni's house is closest to

A. 25
B. 33
C. 38
D. 41
E. 49

Question 7

The diagram below shows a tent in the shape of a square prism with a square right pyramid on top.

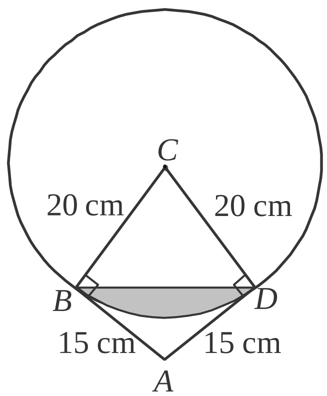


A pole, *OV*, which supports the vertex of the roof, *V*, sits inside the tent and has its base at *O*, which lies vertically below *V*.
The sidelengths of the square prism are 4 metres, and the slant edges of the pyramid are of length 3 metres. The length of the pole, in metres, is equal to

A. 1
B. 4.8
C. 5
D. 6.2
E. 6.8

Question 8

The diagram below shows a circle of radius 20 cm and centre at *C*.
Points *B* and *D* lie on the circle and angles *ABC* and *ADC* are both 90°.



Sidelengths *AB* and *AD* are both 15 cm.
The area of the shaded segment, in square centimetres, is closest to

A. 65
B. 141
C. 192
D. 257
E. 457

Module 4: Graphs and relations

If you choose this module all questions must be answered.

Question 1

The line that passes through the points $(3,-1)$ and $(3, 3)$ has the equation

A. $x = 3$

B. $y = 3$

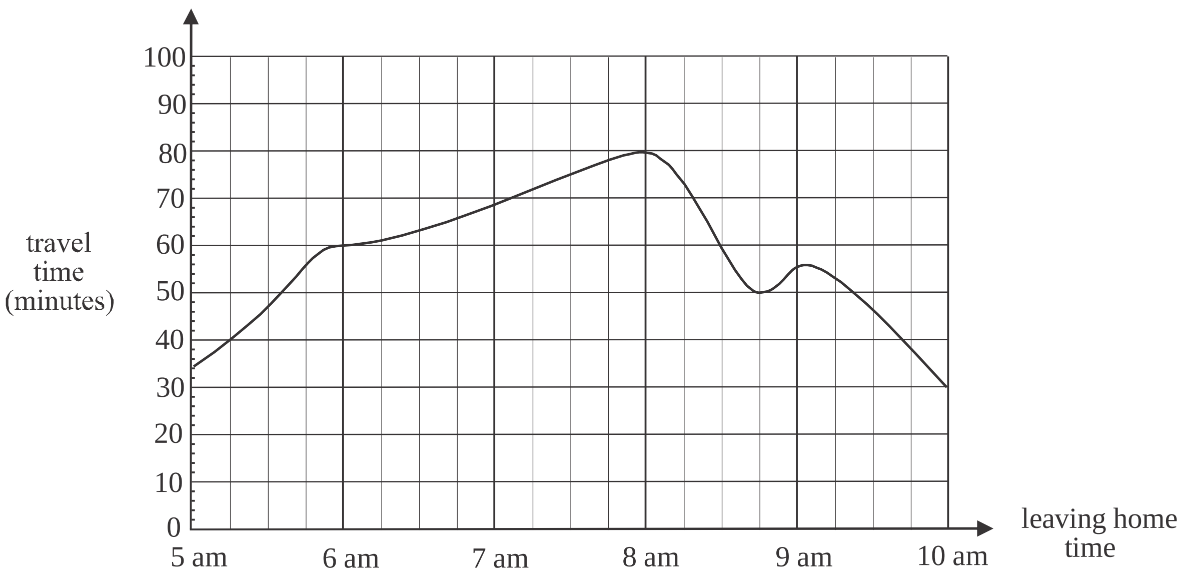
C. $y = \frac{x}{3}$

D. $y = \frac{-x}{3}$

E. $y = x - 4$

Question 2

The graph below shows the travel time, in minutes, it would take Jason to drive to work against his leaving home time, according to a traffic app.



Which one of the following statements is true?

A. Jason's quickest trip to work occurs if he leaves home at 8am.
B. Jason will get to work quicker if he leaves home at 6am rather than 8.30am.
C. Jason's slowest trip to work occurs if he leaves home at 10am.
D. Jason will get to work slower if he leaves home at 6am rather than 8am.
E. Jason will take an hour or more to get to work if he leaves home between 6am and 8.30am.

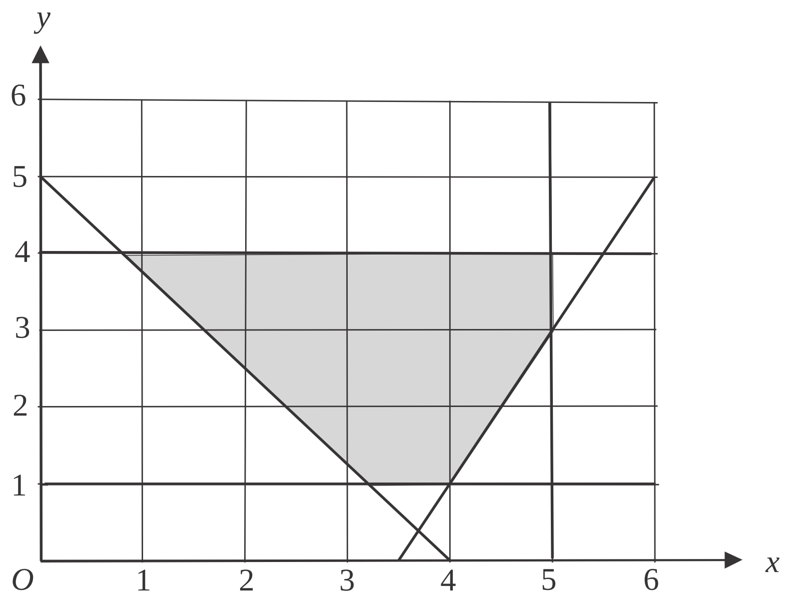
Question 3

Members of a cricket club pay an annual registration fee of $180 plus umpire fees of $15 for every game they play in.
Which one of the following amounts could **not** represent a member's total payment for the season?

A. $255
B. $300
C. $360
D. $380
E. $390

Question 4

The feasible region defined by five inequalities is represented by the shaded region on the graph below.



Which one of the following inequalities could be used to help define this feasible region?

A. $1 \le x \le 4$
B. $y \le 5$
C. $2x - y \ge 7$
D. $5x + 4y \ge 20$
E. $x + y \ge 20$

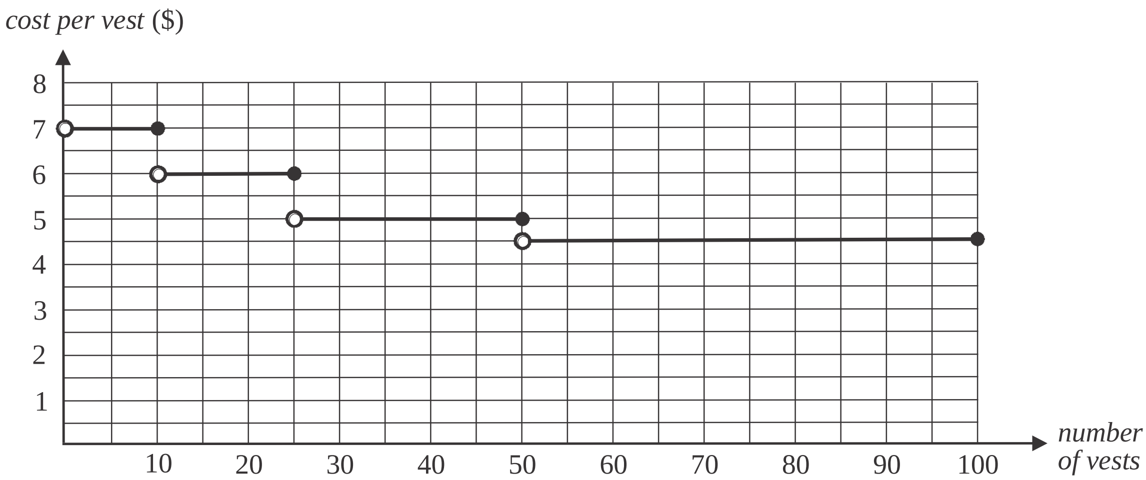
Question 5

A nursing home requires at least one registered nurse for every eight nursing home residents.
Let x be the number of registered nurses.
Let y be the number of residents.
The inequality that represents this requirement is given by

A. $y \le \frac{x}{8}$
B. $y \ge 8x$
C. $y \le 8x$
D. $y \ge \frac{x}{8}$
E. $y \le \frac{8}{x}$

Question 6

The step graph below shows the *cost per vest*, in dollars, when purchasing hi-vis safety vests, based on the *numbers of vests* bought in one transaction.



Last March a business purchased 5 vests in one transaction.
In June it purchased another 25 vests in one transaction and in September it purchased yet another 70 vests in one transaction.
The total cost to the business for these three transactions is

A. \$17.50
B. \$450
C. \$475
D. \$500
E. \$565

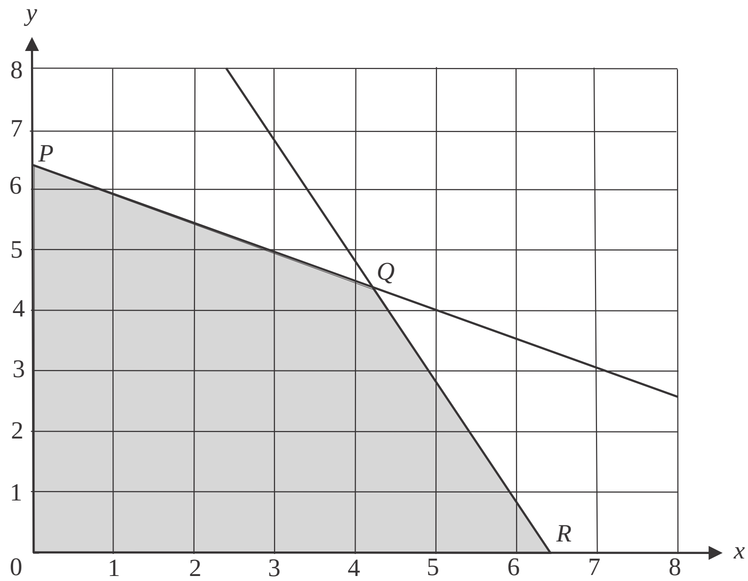
Question 7

A shoe retailer is having an end of season sale.
Short boots are selling for \$60 a pair and long boots are selling for \$90 a pair.
Elisse and her friends bought 11 pairs of boots between them for a total of \$750.
The number of long boots that Elisse and her friends bought between them is

A. 2
B. 3
C. 5
D. 7
E. 8

Question 8

The graph below shows the feasible region, indicated by the shaded area, for a linear programming problem.



The objective function *Z*, and the point where its maximum value occurs, are given respectively by

A. $Z = 4x + y$ and point *P*
B. $Z = 4x + y$ and point *Q*
C. $Z = x + 6y$ and point *P*
D. $Z = x + 6y$ and point *R*
E. $Z = x + y$ and point *R*

Further Mathematics formulas

Core - Data analysis

standardised score	$z = \frac{x - \bar{x}}{s_x}$
lower and upper fence in a boxplot	lower $Q_1 - 1.5 \times IQR$ upper $Q_3 + 1.5 \times IQR$
least squares line of best fit	$y = a + bx$, where $b = r\frac{s_y}{s_x}$ and $a = \bar{y} - b\bar{x}$
residual value	residual value = actual value – predicted value
seasonal index	seasonal index $= \frac{\text{actual figure}}{\text{deseasonalised figure}}$

Core – Recursion and financial modelling

first-order linear recurrence relation	$u_0 = a, \quad u_{n+1} = bu_n + c$
effective rate of interest for a compound interest loan or investment	$r_{effective} = \left[\left(1 + \frac{r}{100n}\right)^n - 1\right] \times 100\%$

Module 1 - 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 $\det A \neq 0$
recurrence relation	$S_0 =$ initial state, $\quad S_{n+1} = TS_n + B$

Module 2 - Networks and decision mathematics

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

Module 3 – Geometry and measurement

area of a triangle	$A=\frac{1}{2}bc\sin(\theta°)$
Heron's formula	$A=\sqrt{s(s-a)(s-b)(s-c)}$, where $s=\frac{1}{2}(a+b+c)$
sine rule	$\frac{a}{\sin(A)}=\frac{b}{\sin(B)}=\frac{c}{\sin(C)}$
cosine rule	$a^2=b^2+c^2-2bc\cos(A)$
circumference of a circle	$2\pi r$
length of an arc	$r\times\frac{\pi}{180}\times\theta°$
area of a circle	πr^2
area of a sector	$\pi r^2\times\frac{\theta°}{360}$
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 prism	area of base $\times$ height
volume of a pyramid	$\frac{1}{3}\times$ area of base $\times$ height

Module 4 – Graphs and relations

gradient (slope) of a straight line	$m=\frac{y_2-y_1}{x_2-x_1}$
equation of a straight line	$y=mx+c$

END OF FORMULA SHEET

FURTHER MATHEMATICS

TRIAL EXAMINATION 1

MULTIPLE- CHOICE ANSWER SHEET

STUDENT NAME:..

INSTRUCTIONS

Fill in the letter that corresponds to your choice. Example: A ■ C D E

The answer selected is B. Only one answer should be selected.

Section A - Core

1.	A	B	C	D	E
2.	A	B	C	D	E
3.	A	B	C	D	E
4.	A	B	C	D	E
5.	A	B	C	D	E
6.	A	B	C	D	E
7.	A	B	C	D	E
8.	A	B	C	D	E
9.	A	B	C	D	E
10.	A	B	C	D	E
11.	A	B	C	D	E
12.	A	B	C	D	E
13.	A	B	C	D	E
14.	A	B	C	D	E
15.	A	B	C	D	E
16.	A	B	C	D	E
17.	A	B	C	D	E
18.	A	B	C	D	E
19.	A	B	C	D	E
20.	A	B	C	D	E
21.	A	B	C	D	E
22.	A	B	C	D	E
23.	A	B	C	D	E
24.	A	B	C	D	E

Section B - Modules

Module Number ___

1.	A	B	C	D	E
2.	A	B	C	D	E
3.	A	B	C	D	E
4.	A	B	C	D	E
5.	A	B	C	D	E
6.	A	B	C	D	E
7.	A	B	C	D	E
8.	A	B	C	D	E

Module Number ___

1.	A	B	C	D	E
2.	A	B	C	D	E
3.	A	B	C	D	E
4.	A	B	C	D	E
5.	A	B	C	D	E
6.	A	B	C	D	E
7.	A	B	C	D	E
8.	A	B	C	D	E