The Mathematical Association of Victoria

Trial Exam 2015

FURTHER MATHEMATICS

Written Examination 1

STUDENT NAME: ……

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

MULTIPLE-CHOICE QUESTION BOOK

Structure of Book

Section	*Number of questions*	*Number of questions to be answered*	*Number of Modules*	*Number of modules to be answered*	*Number of marks*
A	13	13			13
B	54	27	6	3	27
					Total 40

- 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, with a detachable sheet of miscellaneous formulas in the centrefold.
- Answer sheet for multiple-choice questions.
- Working space is provided throughout the book.

Instructions

- Detach the formula sheet from the centre of this book during reading time.
- Unless otherwise indicated, the diagrams in this book are NOT drawn to scale.

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

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SECTION A

Instructions for Section A

Answer all questions in pencil on the answer sheet provided for multiple-choice questions.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any questions.

Core: Data analysis

Question 1

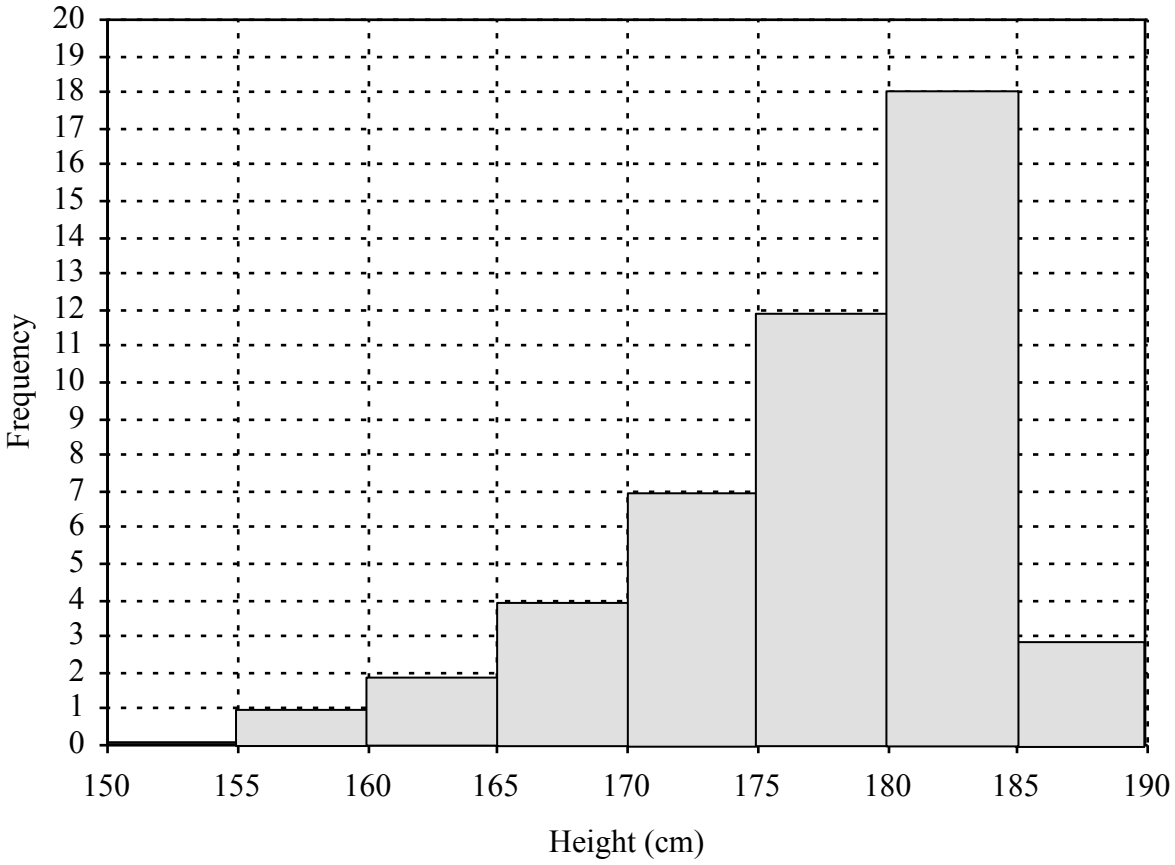
100 students were asked how many hours (to the nearest hour) of Further Maths homework they completed in one week. The results of the survey are given in a frequency table below:

Hours of home work	Frequency
0	2
1	4
2	8
3	7
4	25
5	30
6	20
7	4

The mean number of hours, correct to one decimal place, of Further Maths homework completed was:

A 3.5
B 4.0
C 4.2
D 4.4
E 5.0

The following histogram contains the heights in centimetres of 47 players in the Firsts and Seconds of the Newtown football club.



Question 2
The shape of the histogram is best described as:

A Symmetric
B Positively skewed
C Negatively skewed
D Bimodal
E Symmetric with outliers

Question 3
The following stemplot contains the average life expectancies of a sample of twenty Asian countries.

Stem	Leaf
63	5 8
64	
65	9
66	
67	1 2 4 8
68	
69	0 0 8
70	7
71	
72	2 5 9
73	
74	2 5
75	2 2
76	4 8

63|5 represents 63.5 years

Based on data from CIA Factbook, 2014

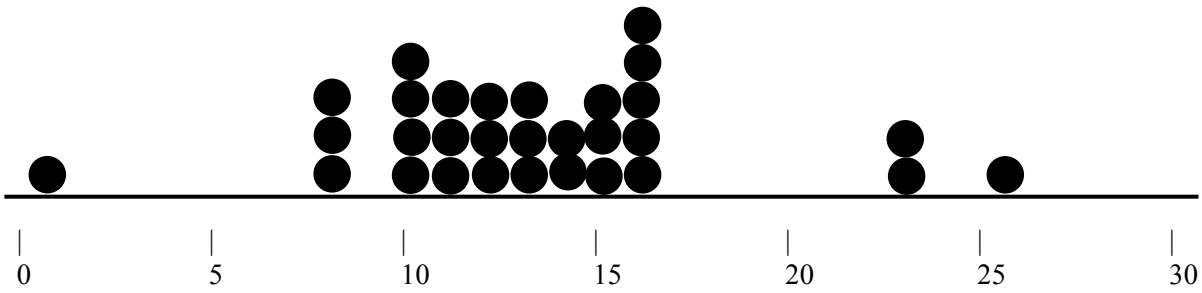
The median average life expectancy for these Asian countries, correct to one decimal place, is :

A. 69.4
B. 69.8
C. 70.3
D. 70.4
E. 70.7

Question 4
For fifty European countries, the average life expectancies are approximately normally distributed with a mean of 78.4 and a standard deviation of 3.9. Switzerland has an average life expectancy of 82.3 years. What approximate percentage of these European countries have average life expectancies less than Switzerland ?

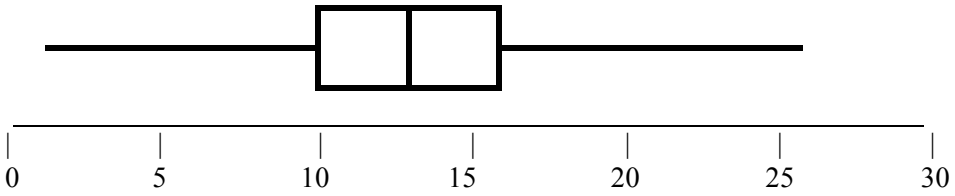
A. 16%
B. 32%
C. 50%
D. 68%
E. 84%

Question 5
The following dotplot shows the number of tribal languages spoken in each of thirty African countries.

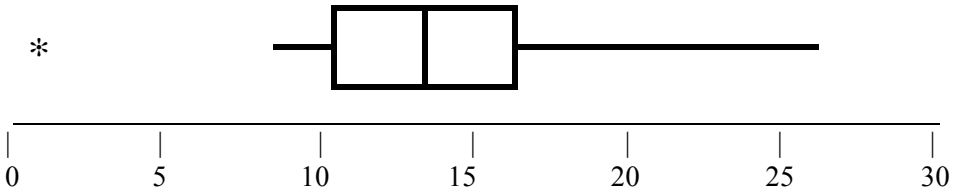


Which of the following boxplots best represents the data ?

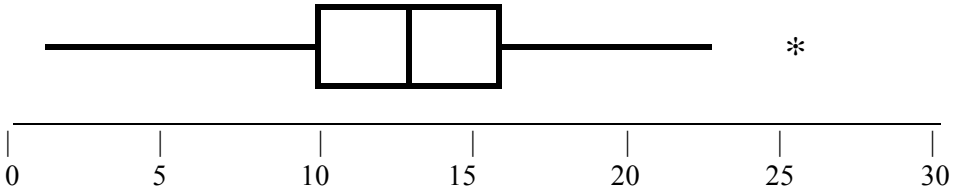
A.



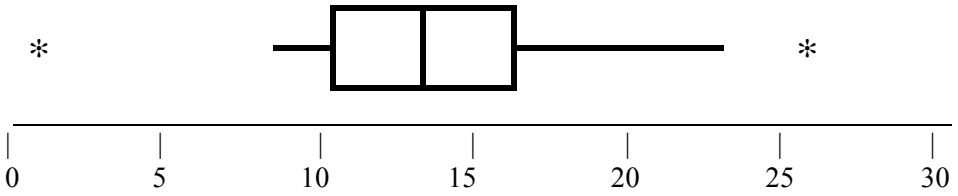
B.



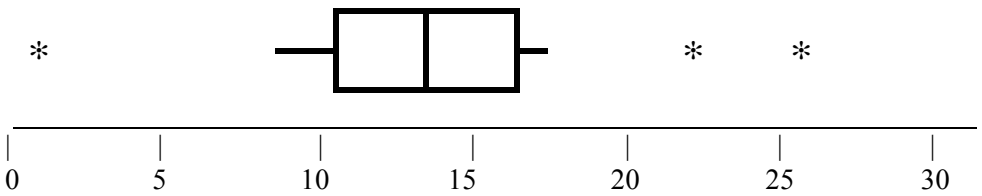
C.



D.



E.



SECTION A – continued

Question 6
A group of students was surveyed and asked how regularly they completed homework. The answers were 1 = regularly, 2 = sometimes, 3 = rarely and 4 = never. Their answers were to be displayed to make a comparison between these responses and their gender, male or female. An appropriate display for this survey might be

A A two way frequency table
B A histogram
C Parallel boxplots
D A back to back stem and leaf plot
E A scatterplot

The following information relates to both Questions 7 and 8.
WTA ranking refers to the Women's Tennis Association rankings of the top women tennis players on the international circuit.

Question 7
The least squares regression line for the relationship between the WTA ranking of the top 10 female tennis players and the income earned (in $million) in 2013 is:

$$Income = 7.58 - 0.60 \times ranking$$

Sara Errani is ranked number six at the end of the 2013 with an income of $2.6 million. The residual of Sara Errani's income in $million is closest to:

A – 1.4
B 1.4
C 4.0
D – 2.0
E 2.0

Question 8
The WTA ranking of the top 10 female tennis players at the end of 2014 and their yearly income in $million, correct to one decimal place, is shown below. It is assumed that the ranking can be used to predict the income:

Ranking	1	2	3	4	5	6	7	8	9	10
Income in $million	9.3	5.8	5.2	4.5	3.4	3.4	3.2	3.2	2.6	2.4

The relationship is not linear and a reciprocal transformation of the "ranking" variable is performed. The transformed relationship is written correct to 2 decimal places. The equation predicts that the 3rd ranked player would earn an income closest to:

A $24.3 million
B $8.1 million
C $5.2 million
D $4.6 million
E $0.1 million

Question 9
A large study of Year 12 students shows that there is a negative association between the time spent doing homework each week and the time spent on social media. The correlation coefficient is $r = -0.75$.

From this information it can be concluded that

A. the time spent doing homework is 75% lower than the time spent on social media.
B. 56% of students spend more time on social media than doing homework.
C. the slope of the least squares regression line is – 0.75.
D. if a student spends less time on social media, they will do more homework.
E. an increased time spent on social media is associated with a decreased time doing homework.

Question 10
A teacher was reviewing the results from two Core practice tasks for her Further Mathematics class.
For *Task 1*, the mean was 20.57 and the standard deviation was 6.08.
For *Task 2*, the mean was 31.86 and the standard deviation was 10.59.
The Pearson's product moment correlation coefficient (r) was 0.965, with *Task 2* as the dependent variable.

The equation of the least squares regression line is closest to

A. *Task 2* = – 2.70 – 1.68 × *Task 1*
B. *Task 2* = – 2.70 + 1.68 × *Task 1*
C. *Task 2* = 20.55 – 0.55 × *Task 1*
D. *Task 2* = 20.55 + 0.55 × *Task 1*
E. *Task 1* = 66.42 + 1.68 × *Task 2*

Question 11
The seasonal indices for 10 months of the year for sales in a menswear store, are shown in the table below.

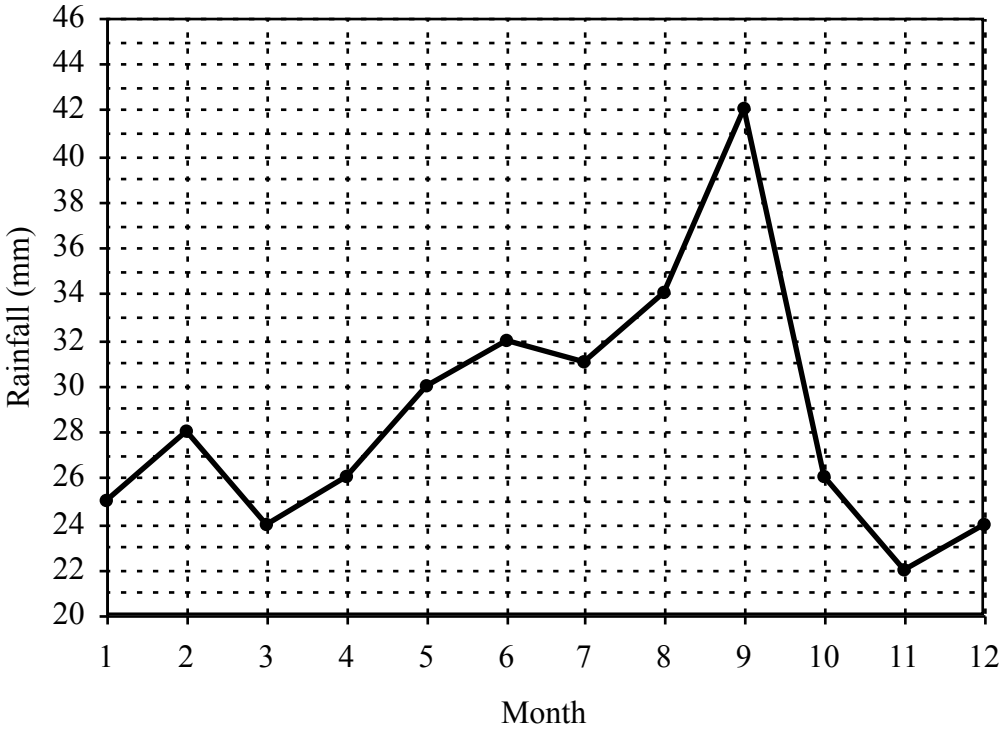
Month	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
SI	0.47	0.88		0.99	1.08	1.31	1.48	1.32	1.23		0.77	0.53

The seasonal index for March is identical to the seasonal index for October.

This seasonal index value is:

A. 0.65
B. 0.82
C. 0.88
D. 0.97
E. 1.94

Question 12
The monthly rainfall in a small coastal town is recorded and graphed on the time series plot below:



A five point median smoothing is completed on the graph. The smoothed value for the 8th month would be:

A 26 mm
B 31 mm
C 32 mm
D 33 mm
E 34 mm

Question 13
In analysing its sales for summer over a number of years, an air-conditioning retailer noted that to correct for seasonality, its actual summer sales value needed to be reduced by 25%.

This means that the seasonal index for summer is closest to :

A. 1.00
B. 1.20
C. 1.25
D. 1.33
E. 1.50

END OF SECTION A

SECTION B

Instructions for Section B

Select **three** modules and answer all questions within the modules selected in pencil on the answer sheet provided for multiple-choice questions.

Show the modules you are answering by shading the matching boxes on your multiple-choice answer sheet **and** writing the name of the module in the box provided.

Choose the response that is **correct** for the question.

A correct answer scores 1, an incorrect answer scores 0.

Marks will **not** be deducted for incorrect answers.

No marks will be given if more than one answer is completed for any questions.

MODULE 1: Number Patterns

Before answering these questions you must **shade** the Number patterns box on the answer sheet for multiple-choice questions and write the name of the module in the box provided.

Question 1
The arithmetic sequence containing the consecutive terms…, 13, 16, 19, … has a first term greater than 1.

The first term is:

A. 2
B. 3
C. 4
D. 5
E. 6

Question 2
The sum of the first three terms of an arithmetic sequence is 3.

If the first term is 5, what is the common difference?

A. – 4
B. – 2
C. 0
D. 2
E. 4

Question 3
The fifth term of a geometric sequence is 405, and the second term of the same sequence is – 15.

The value of the common ratio is :

A. – 5
B. – 3
C. – 1.5
D. 3
E. 5

Question 4
A difference equation is $t_{n+1} = 2t_n - 3$, where $t_3 = 27$.

What is the value of t_1?

A. 6
B. 7
C. 8
D. 9
E. 10

Question 5
At the end of the first day of a volcanic eruption, 20 km^2 of ground was covered with lava.
At the end of the second day, an additional 19 km^2 of ground was covered.
At the end of the third day, an additional 18.05 km^2 of ground was covered.
The total area of ground covered by lava from the volcanic eruption continues to increase in this way.
In square kilometres, the total area of ground covered by lava from the volcanic eruption by the time the volcano finishes erupting is closest to

A. 256
B. 350
C. 381
D. 400
E. 441

Question 6
The first two terms of a Fibonacci-related sequence are both p.
That is, the first two terms are p, p, …
If a number is substituted for p, then the sixth term of this sequence has the value 48.

What number was substituted for p ?

A. 4
B. 5
C. 6
D. 7
E. 8

Question 7
The sum of the first four terms of a geometric sequence has the value – 30.
The sum of the first and third terms is 30.

The value of the common ratio for this sequence is :

A. – 3
B. – 2
C. – 1
D. 0
E. 1

Question 8
The residents of a particular rural valley do not inoculate their children against childhood diseases like Diptheria. Unfortunately a visitor to the valley was a carrier for Diptheria and it soon started spreading around the children in the valley.
On one day, the valley doctor had 15 children with Diptheria and estimated that each day thereafter the number of children with Diptheria increased by 35%.

If this pattern continued, how many days would it take for all 135 children in the valley to become infected with Diptheria?

A. 3
B. 6
C. 9
D. 18
E. 23

Question 9
Dan has a dam on his farm for his animals to drink water. It contains 4500 L when full. During the hot days in February, 20% of the water evaporates each day. However, each night, Dan pumps 500L into the dam from a storage tank.

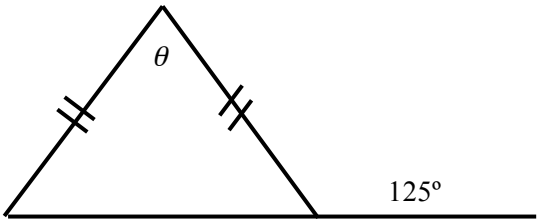
If a hot spell started on February 1st and continued into March, which of the following statements will be true, with measurements rounded to the nearest whole litre ?

A. In 28 days, the dam will be dry
B. Dan will have to stop pumping water overnight as the dam will be overfull before the end of February.
C. The dam will reach a constant volume by the end of the first fortnight in February
D. The dam will reach a constant volume by the 28th of February.
E. The dam will reach a constant volume by sometime in March.

MODULE 2: Geometry and trigonometry

Before answering these questions you must **shade** the Geometry and trigonometry box on the answer sheet for multiple-choice questions and write the name of the module in the box provided.

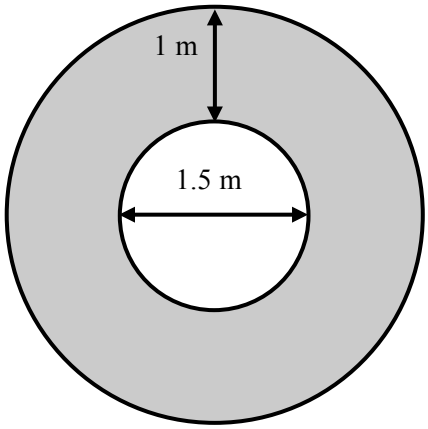
Question 1



The value of angle θ is :

A. 60º
B. 65º
C. 70º
D. 75º
E. 80º

Question 2



A circular path surrounds a circular pond 1.5 m in diameter.
If the path is 1 m wide, what area, to the nearest square metre, of non-skid coating will be required to completely cover the path?

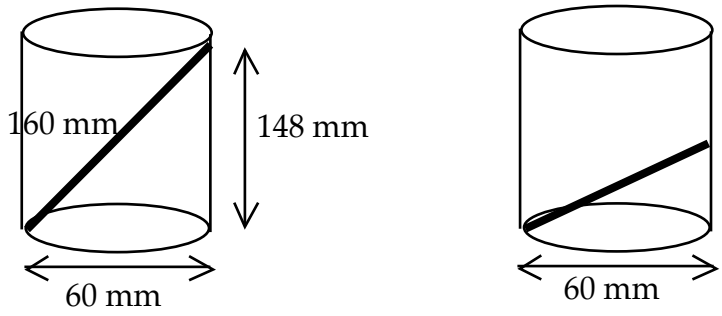
A. 3
B. 8
C. 11
D. 13
E. 18

Question 3
A boat is at anchor on a large lake while training students to take accurate bearings.
One student reports that the bearing from the boat to the main jetty is 048º. Another student reports that the bearing of a navigational marker from the boat is 076º. Looking at her map, the captain realises that the bearing of a navigational marker from the main jetty will be half the bearing of the boat from the main jetty.

The bearing of the navigational marker from the main jetty will be closest to :

A. 114º
B. 128º
C. 180º
D. 228º
E. 256º

Question 4
Sam is playing with cans and straws. He knows that a 160 mm straw will sit in a 60 mm diameter can as shown below left, with the top just touching the top of the can which is 148 mm high. When he cuts the straw in half and drops in the can, it reaches only partway up the can, as shown below right.



How high above the base does the shortened straw reach, correct to the nearest mm?

A. 53
B. 74
C. 95
D. 100
E. 125

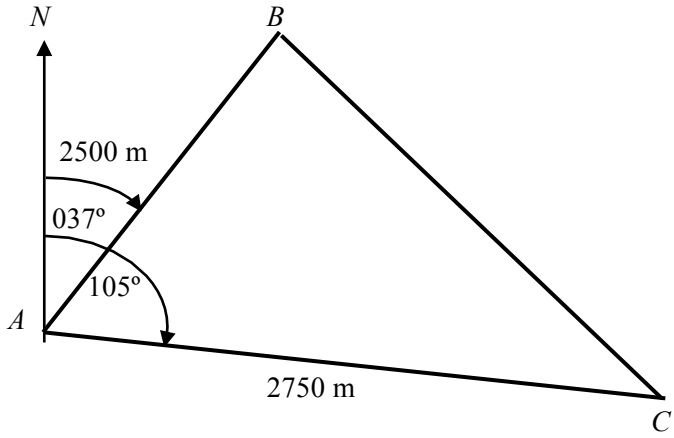
Question 5
On his beach property, George built a beach house.

He also built a cubby house for his children, that was a $\frac{2}{5}$ scale model of his beach house.

To paint the outside walls of the cubby house required 1.5 L of paint that covered 8m^2 per litre.
The number of litres of paint required to paint the outside walls of the beach house at the same paint spread rate will be closest to :

A. 4
B. 10
C. 16
D. 23
E. 30

Use the following information to answer Questions 6 and 7.
A yacht race is being run on a triangular course.



From the start at marker *A*, the yachts travel 2500 m on bearing 037º to marker *B*. From marker *B* they will travel to marker *C,* which is 2750 m on a bearing of 105º from marker *A*, as shown in the diagram above. From marker *C*, yachts will return to marker *A*.

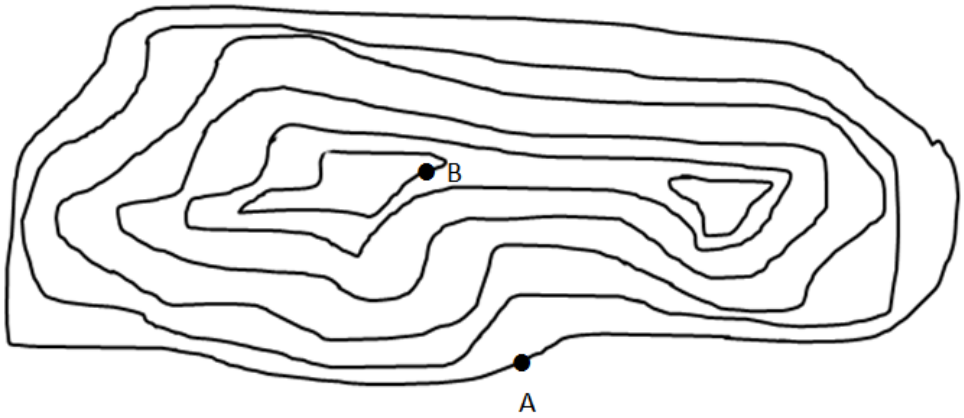
Question 6
What is the distance, correct to the nearest metre, from marker *B* to marker *C* ?

A. 2759
B. 2943
C. 3310
D. 3717
E. 4168

Question 7
On what bearing should the yachts sail on a direct line from marker *B* to marker *C*?

A. 120º
B. 135º
C. 150º
D. 157º
E. 165º

Question 8



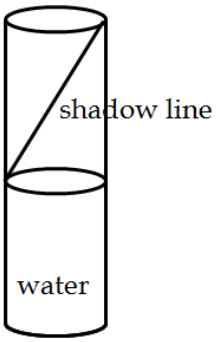
This contour map has contours at 50 m intervals.
Point *A* is on the 150 m contour.
A chairlift is to be built to take passengers from point *A* to point *B*, and the angle of elevation of point *B* from point *A* is 24º.
The length of chairlift cable required will be twice the direct distance from point *A* to Point *B* plus another 20% to allow for cable sag between pylons and going around the drive wheels.

The total length of cable required, in metres, will be closest to :

A. 615
B. 983
C. 1475
D. 1966
E. 2360

Question 9.

While peering down a 1 m diameter well late one sunny morning, Amy noticed that the shadow from the edge of the well opening was exactly at the water level. At the same time, a 750 mm tall stake cast a shadow 200 mm long.



How far, in metres, below the well opening is the water level?

A. 0.75
B. 2.25
C. 3.05
D. 3.75
E. 5.25

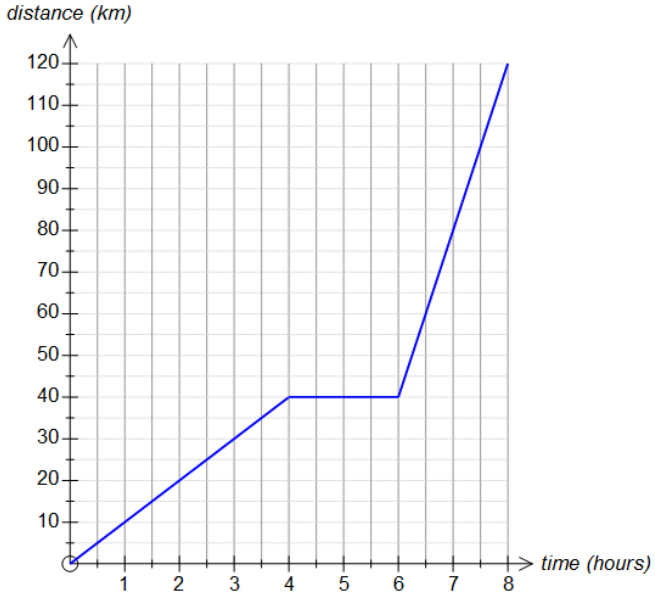
MODULE 3: Graphs and relations

Before answering these questions you must shade the Graphs and relations box on the answer sheet for multiple-choice questions and write the name of the module in the box provided.

Question 1
A horizontal line passes through the point (5, 4). The equation of this line would be:

A $y = 5$
B $x = 5$
C $y = 4$
D $x = 4$
E $x + y = 4$

The information below relates to questions 2 and 3:
Mitch is going to a friend's house. He rides his bike from his starting point for the first part of the journey then stops and waits until he is picked up in his friend's car. He travels the remainder of the journey by car. A graph showing the distance that he has travelled in total is shown below:



Question 2
The average speed in kilometres per hour that Mitch rides his bicycle is closest to:

A 40 km/h
B 15 km/h
C 6.7 km/h
D 0.1 km/h
E 10 km/h

Question 3
The relationship between Mitch's distance and the time during his journey is given by:

A $$d = \begin{cases} 10 & 0 < t \le 4 \\ 40t & 4 < t \le 6 \\ 40t - 200 & 6 < t \le 8 \end{cases}$$

B $$d = \begin{cases} 10t & 0 < t \le 4 \\ 40 & 4 < t \le 6 \\ 40t - 200 & 6 < t \le 8 \end{cases}$$

C $$d = \begin{cases} 10t & 0 < t \le 4 \\ 40 & 4 < t \le 6 \\ 40t + 40 & 6 < t \le 8 \end{cases}$$

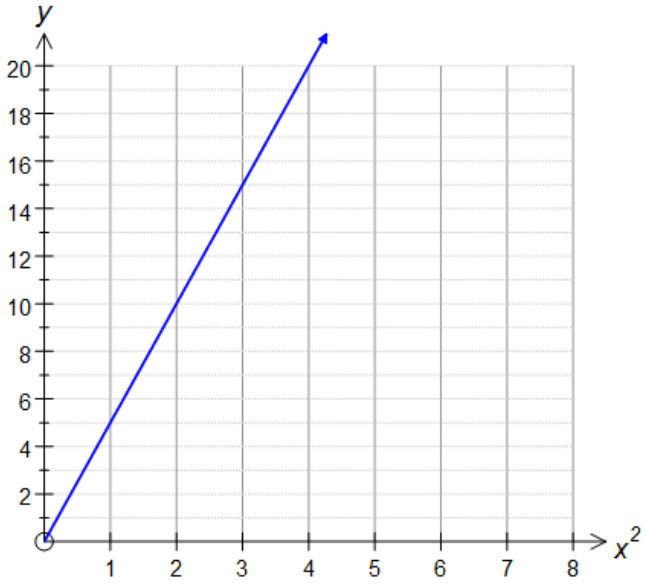
D $$d = \begin{cases} 10t & 0 < t \le 4 \\ 40 & 4 < t \le 6 \\ 40t & 6 < t \le 8 \end{cases}$$

E $$d = \begin{cases} 10t & 0 < t \le 8 \\ 40 & 4 < t \le 6 \\ 40t - 200 & 0 < t \le 8 \end{cases}$$

Question 4
One line passes through the points (– 2, – 10) and (5, 4). Another line passes through the points (4, – 3) and (– 2, 15). A point that is on both of these lines is:

A (3, 0)
B (4, 2)
C (10, – 21)
D (0, 3)
E (1, – 4)

Question 5
A graph is shown below.



The equation of the graph is:

A $y = 5x^3$

B $y = 0.2x^2$

C $y = 5x^2$

D $y = 5x$

E $y = 0.2x$

Question 6
A linear programming problem involves a business that manufactures chairs (x) and tables (y). One of the constraints is that there must be at least 6 chairs for every table manufactured. The correct inequation for this constraint would be:

A $y \leq 6x$

B $y \leq \frac{1}{6}x$

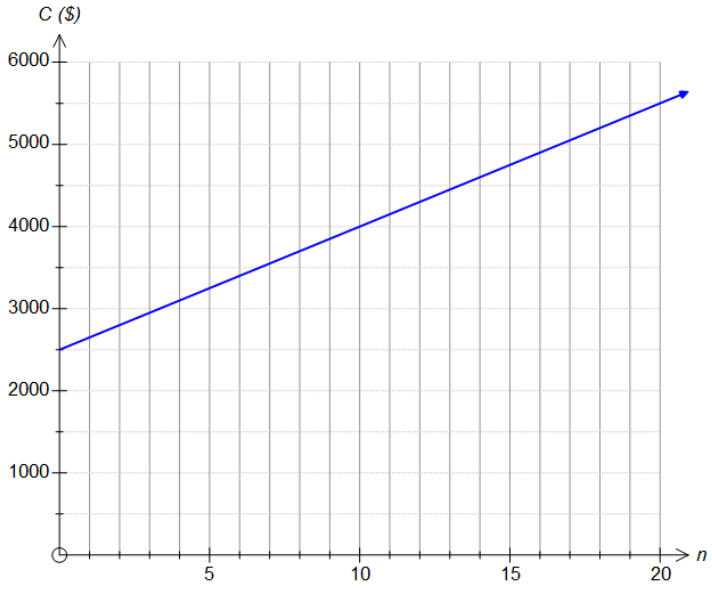
C $y \geq 6x$

D $y \geq \frac{1}{6}x$

E $y \geq x + 6$

Question 7

A company manufactures washing machines. A graph is shown below of the relationship between the cost of manufacturing the products (C) and the number of washing machines made (n) for each month. The relationship remains the same for as many machines as the company can make. The graph shows the relationship for up to 20 machines:



The company makes a profit of $13500 when they sell 120 washing machines. The selling price for each machine is:

A $112.50
B $258.33
C $1275
D $1700
E $2500

Question 8

The constraints of a linear programming problem are given by the following set of inequalities.

$2x + y \leq 20$

$y \geq 2x$

$y \leq 8x$

$y \geq 4$

The coordinates of the points that define the boundaries of the feasible region for this linear programming problem are:

A (0.5, 4), (2, 16), (5, 10), (2, 4)

B (0, 4), (2, 16), (0, 20), (0.5, 4)

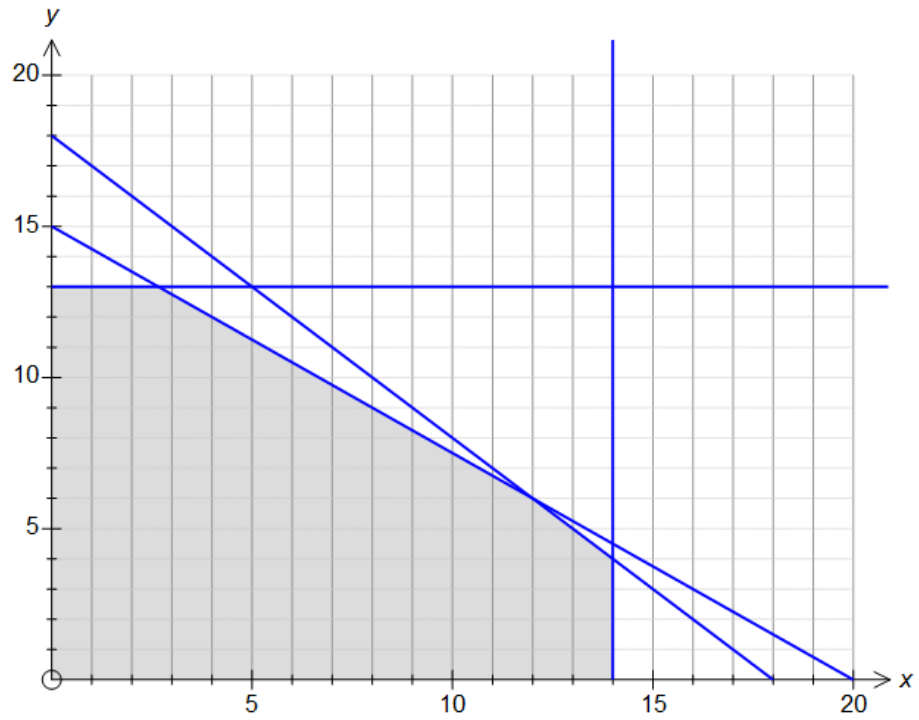
C (8, 4), (5, 10), (2, 4)

D (0.5, 4), (0, 0), (2, 4)

E (0, 20), (2, 16), (5, 10), (2, 4)

Question 9

The feasible region for a linear programming problem is shown as the shaded region on the graph below. For this problem x represents the number of members and y represents the number of non-members staying at a resort:



Each member pays \$150 per night and each non-member pays \$200 per night to stay at the resort. The maximum income that the resort can make per night is represented by the point(s):

A (14, 4) and (12, 6)

B $\left(2\frac{2}{3}, 13\right)$ and (12, 6)

C (3, 13) and (12, 6)

D (2, 13) and (12, 6)

E (4, 12), (8, 9) and (12, 6)

Module 4: Business-related mathematics

Before answering these questions you must **shade** the Business-related mathematics box on the answer sheet for multiple-choice questions and write the name of the module in the box provided.

Question 1
William runs a petrol station in a small rural community. Due to a massive drop in the global price of crude oil, the cost of his next delivery of petrol will drop by 7.5%.

If he paid $25 000 for his last delivery, what will he pay for the next one?

A. $1875
B. $23 125
C. $23 375
D. $24 992.50
E. $26 875

Question 2
A school canteen needs a new refrigerator. They have seen the one they want, listed at $2695 (including 10% GST). A Government grant will pay the cost of the GST.

What will be the amount of the grant required, correct to the nearest cent?

A. $224.58
B. $245.00
C. $269.50
D. $296.50
E. $2450.00

Question 3
Julie invests $17 000 at 4.2% per annum simple interest for 5 months. The value of her investment at the end of the 5 months is closest to :

A. $297.50
B. $299.59
C. $17 297.50
D. $17 299.59
E. $17 595.00

Question 4
Due to intense competition in the smartphone market, it is estimated the value of new phones will decrease by 7.5% per month. Reggie had just bought a new smartphone for $650. The number of months it will take for his phone to lose half of its value is closest to

A. 6
B. 8
C. 9
D. 11
E. 13

Question 5
Michael is buying a house and has borrowed $300 000 from a bank to finance the purchase. He will be charged 6.75% per annum interest on the reducing monthly balance and will make monthly repayments of $2400.

How long, in years and months, will it take him to fully repay the loan ?

A. 18 years 0 months
B. 18 years 1 months
C. 18 years 3 months
D. 18 years 5 months
E. 18 years 6 months

Question 6
Leslie was provided with a car by her employer, it was initially valued at $32 000 and depreciated by 42.5¢ for every kilometre travelled.

If it was to be traded in for a new vehicle when its value was $20 000, how many kilometres would it have travelled?

A. 20 000
B. 28 235
C. 31 113
D. 47 059
E. 75 294

Question 7
Sianna is buying a refrigerator using hire purchase. The refrigerator had a cash price of $1350.00, and Sianna has bought it on a hire-purchase plan with a deposit of $100.00 and monthly repayments of $65.00 for two years.

The effective annual interest rate charged on this loan is closest to:

A. 12.4%
B. 19.1%
C. 23.8%
D. 38.2%
E. 47.6%

Question 8
Shelley was saving to buy a new car. She invested $3000 at 4.00% per annum compounding monthly. Immediately after the interest was paid each month, she deposited a sum of money to this account. She added the same amount each month for six months, and the value of her investment after the sixth payment was made was $5480.59.

The amount she added to the account each month was closest to:

A. $341
B. $393
C. $400
D. $413
E. $432

Question 9
Louise has borrowed $350 000 to buy a home. The bank will charge 6.45% per annum on the reducing monthly balance, and she will make monthly repayments of $2600. After five full years, the interest rate is increased to 6.95% per annum.

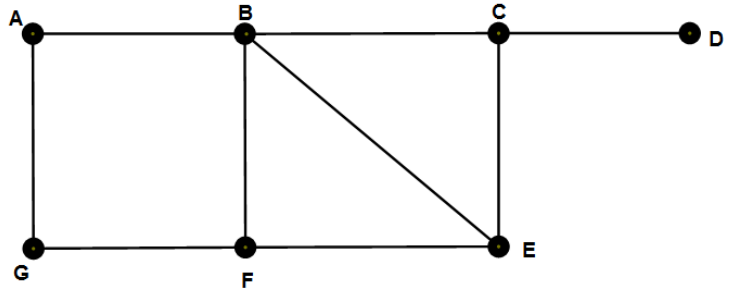
What will be her new repayments, correct to the nearest cent, if she is to repay her loan in exactly the same time as her original loan?

A. $2311.25
B. $2497.83
C. $2610.23
D. $2681.55
E. $2703.05

Module 5: Networks and decision mathematics

Before answering these questions you must **shade** the Networks and decision mathematics box on the answer sheet for multiple-choice questions and write the name of the module in the box provided.

Question 1
A network is shown below:



The network has
A an Eulerian path
B a Hamiltonian path
C an Eulerian circuit
D a Hamiltonian circuit
E more than one option from answers A, B, C and D

Question 2
The number of regions in a complete graph with 4 vertices is

A 2
B 3
C 4
D 5
E 6

Question 3
Five people, Andrea, Brett, Charlie, Digby and Emmett, are playing rock, paper and scissors. Each person plays once against each other person and for each game there is a winner and a loser. The results are drawn in a directed network where an arrow from, for example, Andrea to Brett means that Andrea defeated Brett. An adjacency matrix of the directed network showing the winners and losers is given below:

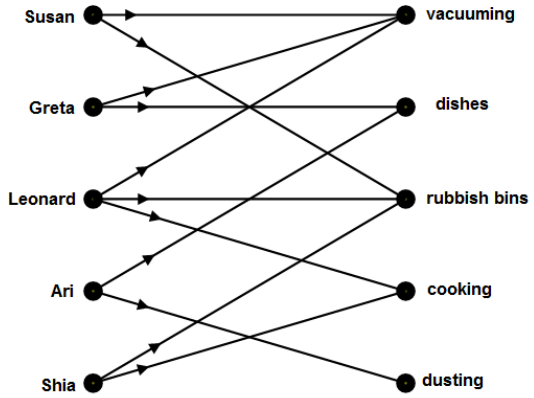
$$\begin{array}{c} \\ A \\ B \\ C \\ D \\ E \end{array} \begin{array}{c} \begin{array}{ccccc} A & B & C & D & E \end{array} \\ \begin{bmatrix} 0 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 \\ 1 & 0 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 \end{bmatrix} \end{array}$$

Which of the following statements is true?
A Andrea has two-step dominances over both Brett and Digby
B Charlie has two-step dominances over both Andrea and Digby
C Emmett has a two-step dominance over Charlie
D Andrea has two two-step dominances over Charlie
E Digby has a total of six two-step dominances over other players

SECTION B - Module 5: Networks and decision mathematics– continued

Question 4

Five friends are sharing a house. They each chose household chores that they would be willing to do. Their choices are shown in the bipartite graph below:



If each person is allocated one task, one possible allocation is:

A Ari – dusting, Greta – dishes, Leonard – vacuuming, Susan – rubbish bins, Shia – cooking

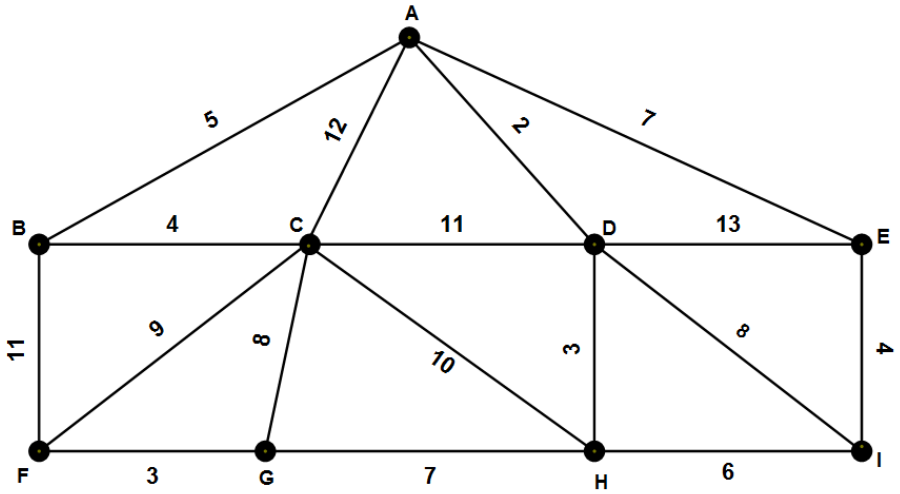
B Ari – dusting, Greta – dishes, Leonard – vacuuming, Shia – rubbish bins, Susan – cooking

C Ari – dishes, Greta – dusting, Leonard – vacuuming, Susan – rubbish bins, Shia – cooking

D Ari – cooking, Greta – dishes, Susan – vacuuming, Leonard – rubbish bins, Shia – dusting

E Ari – dusting, Greta – dishes, Shia – vacuuming, Susan – rubbish bins, Leonard – cooking

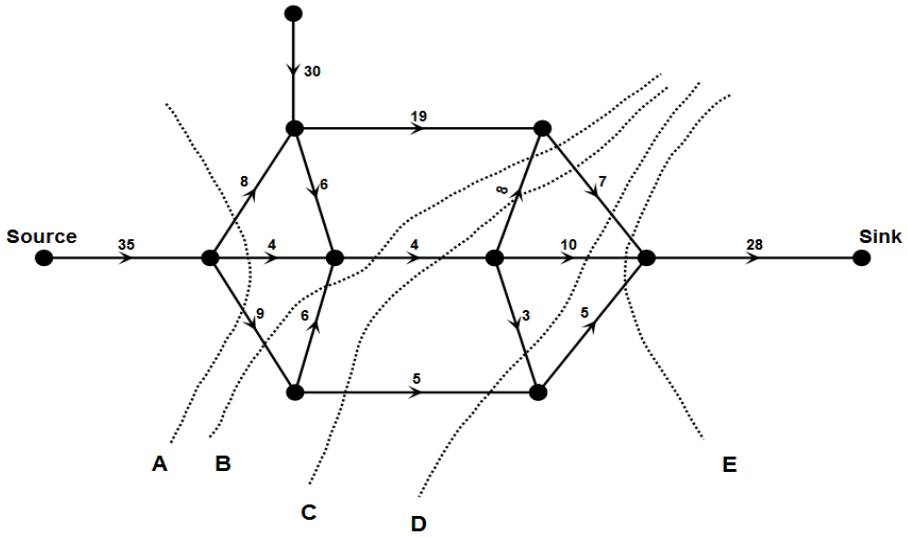
Question 5
A weighted network is shown below:



A student starts a minimum spanning tree at vertex A using Prim's algorithm. The last edge to be connected would be:

A DH
B GH
C EI
D BC
E GF

Question 6
A network representing traffic flow from two locations is shown below:



A number of lines are shown. One of these lines is the minimum cut for the network. The line representing the minimum cut is:
A Line A
B Line B
C Line C
D Line D
E Line E

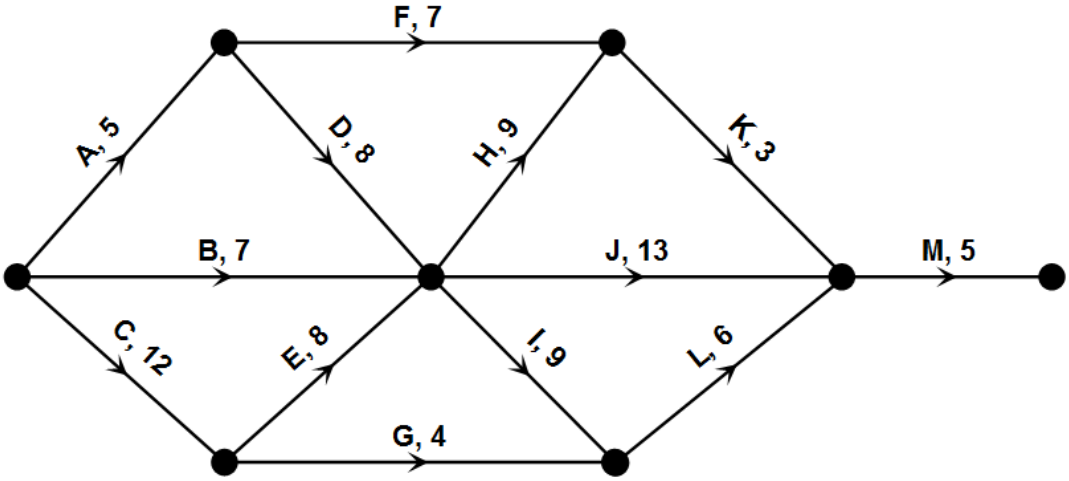
Question 7
A planar, connected, undirected network has 8 vertices and 7 edges. A number of statements about this network are below:

- The network must be a tree
- The network could have an Eulerian circuit
- The network must have an Eulerian path
- The network could have a Hamiltonian path
- Adding an edge to the network will make sure that an Eulerian circuit exists
- The network is complete

How many of the statements are true?

A 1
B 2
C 3
D 4
E 5

The following activity network showing activities in a larger project and their times in hours relates to questions 8 and 9:



Question 8
The critical path for this network is:

A AFKM
B BILM
C CEHKM
D CEJM
E CEILM

Question 9
One activity is to be delayed by five hours. The number of activities that, individually, could be delayed without affecting the overall time taken would be:

A 3
B 4
C 5
D 6
E 7

MODULE 6: Matrices

Before answering these questions you must **shade** the Matrices box on the answer sheet for multiple-choice questions and write the name of the module in the box provided.

Question 1
Matrix P is a 3×4 matrix, matrix Q is a 5×3 matrix and matrix R is a 3×3 matrix. Which of the following expressions is **not** defined?

A QRP
B QP^2
C QR^2P
D $RP + P$
E $QR + Q$

Question 2
The matrix $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 20 \\ 0 & 0 & 0 \end{bmatrix}$ could be obtained by which of the following products?:

A $\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 4 \\ 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 5 \\ 0 & 0 & 0 \end{bmatrix}$

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

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

D $\begin{bmatrix} 0 & 4 & 0 \\ 0 & 0 & 0 \\ 0 & 0 & 0 \end{bmatrix}\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 5 \\ 0 & 0 & 0 \end{bmatrix}$

E $\begin{bmatrix} 20 & 20 & 20 \\ 20 & 20 & 20 \\ 20 & 20 & 20 \end{bmatrix}\begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 1 \\ 0 & 0 & 0 \end{bmatrix}$

Question 3
The determinant of the matrix $\begin{bmatrix} 1 & 5 \\ -2 & 7 \end{bmatrix}$ is given by the expression:

A $1 \times 7 - 5 \times -2$
B $1 \times 7 + 5 \times -2$
C $1 + 7 - 5 + -2$
D $1 \times 5 - 7 \times -2$
E $\dfrac{1}{1 \times 7 - 5 \times -2}$

Question 4

Sarah sells pot plants in three different size decorative pots (small, medium and large) at the local market. She buys the small plants for \$2.50, the medium plants for \$4.70 and the large plants for \$9.80 and then puts each plant in a decorative pot. Small decorative pots are \$1.30, medium decorative pots are \$2.50 and large decorative pots are \$5.10. She calculates her total costs and then adds a mark-up of 40% to determine her selling price. One week Sarah sold all available plants. She sold 35 small plants, 40 medium plants and 24 large plants.

A matrix equation that would give Sarah's total profit P for this week is:

A $$P = 0.4 \times \left(\begin{bmatrix} 2.5 & 4.7 & 9.8 \end{bmatrix} - \begin{bmatrix} 1.3 & 2.5 & 5.1 \end{bmatrix} \right) \times \begin{bmatrix} 35 \\ 40 \\ 24 \end{bmatrix}$$

B $$P = 0.4 \times \left(\begin{bmatrix} 2.5 & 4.7 & 9.8 \end{bmatrix} + \begin{bmatrix} 1.3 & 2.5 & 5.1 \end{bmatrix} \right) \times \begin{bmatrix} 35 \\ 40 \\ 24 \end{bmatrix}$$

C $$P = 1.4 \times \left(\begin{bmatrix} 2.5 & 4.7 & 9.8 \end{bmatrix} + \begin{bmatrix} 1.3 & 2.5 & 5.1 \end{bmatrix} \right) \times \begin{bmatrix} 35 \\ 40 \\ 24 \end{bmatrix}$$

D $$P = 1.4 \times \left(\begin{bmatrix} 2.5 & 4.7 & 9.8 \end{bmatrix} - \begin{bmatrix} 1.3 & 2.5 & 5.1 \end{bmatrix} \right) \times \begin{bmatrix} 35 \\ 40 \\ 24 \end{bmatrix}$$

E $$P = 0.4 \times \begin{bmatrix} 35 \\ 40 \\ 24 \end{bmatrix} \times \left(\begin{bmatrix} 2.5 & 4.7 & 9.8 \end{bmatrix} + \begin{bmatrix} 1.3 & 2.5 & 5.1 \end{bmatrix} \right)$$

Question 5

Three parents buy school supplies through a stationery supplier booklist.
John buys 3 packs of highlighters and 2 USB drives, costing $29.90.
Nicholas buys 4 USB drives and 5 folders, costing $44.30.
Maria buys 1 pack of highlighters and 2 folders, costing $9.10.
If the stationery supplier only supplies one type of each of packs of highlighters (H), USB drives (U) and folders (F), a simultaneous equation written in matrix form that could **not** be used to determine the cost of each item could be:

A $\begin{bmatrix} 0 & 2 & 1 \\ 4 & 5 & 0 \\ 2 & 0 & 3 \end{bmatrix} \begin{bmatrix} U \\ F \\ H \end{bmatrix} = \begin{bmatrix} 9.1 \\ 44.3 \\ 29.9 \end{bmatrix}$

B $\begin{bmatrix} 2 & 0 & 3 \\ 4 & 5 & 0 \\ 0 & 2 & 1 \end{bmatrix} \begin{bmatrix} U \\ F \\ H \end{bmatrix} = \begin{bmatrix} 29.9 \\ 44.3 \\ 9.1 \end{bmatrix}$

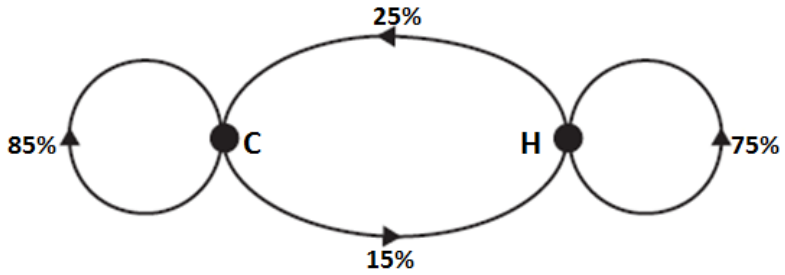
C $\begin{bmatrix} 2 & 0 & 3 \\ 0 & 2 & 1 \\ 4 & 5 & 0 \end{bmatrix} \begin{bmatrix} U \\ F \\ H \end{bmatrix} = \begin{bmatrix} 29.9 \\ 9.1 \\ 44.3 \end{bmatrix}$

D $\begin{bmatrix} 4 & 5 & 0 \\ 2 & 0 & 3 \\ 0 & 2 & 1 \end{bmatrix} \begin{bmatrix} U \\ F \\ H \end{bmatrix} = \begin{bmatrix} 44.3 \\ 29.9 \\ 9.1 \end{bmatrix}$

E $\begin{bmatrix} 2 & 4 & 0 \\ 0 & 5 & 2 \\ 3 & 0 & 1 \end{bmatrix} \begin{bmatrix} U \\ F \\ H \end{bmatrix} = \begin{bmatrix} 29.9 \\ 44.3 \\ 9.1 \end{bmatrix}$

The following information relates to questions 6, 7 and 8:

A café sells cappuccinos (C) and hot chocolates (H). The café has 80 regular customers who each buy either a cappuccino or a hot chocolate every day. On one particular day 35 of the customers bought cappuccinos and 45 customers bought hot chocolates. The customers' choice of drink changes each day according to the transition diagram below:



Question 6

The number of people who are expected to buy each drink the next day is found by evaluating the matrix product:

A
$$\begin{matrix} & C & H \\ \end{matrix}\begin{bmatrix} 0.15 & 0.25 \\ 0.85 & 0.75 \end{bmatrix}\begin{matrix} \\ \end{matrix}\begin{bmatrix} 35 \\ 45 \end{bmatrix}\begin{matrix} C \\ H \end{matrix}$$

B
$$\begin{matrix} & C & H \\ \end{matrix}\begin{bmatrix} 0.85 & 0.25 \\ 0.15 & 0.75 \end{bmatrix}\begin{matrix} \\ \end{matrix}\begin{bmatrix} 45 \\ 35 \end{bmatrix}\begin{matrix} C \\ H \end{matrix}$$

C
$$\begin{matrix} & C & H \\ \end{matrix}\begin{bmatrix} 0.85 & 0.25 \\ 0.75 & 0.25 \end{bmatrix}\begin{matrix} \\ \end{matrix}\begin{bmatrix} 35 \\ 45 \end{bmatrix}\begin{matrix} C \\ H \end{matrix}$$

D
$$\begin{matrix} & C & H \\ \end{matrix}\begin{bmatrix} 0.85 & 0.25 \\ 0.15 & 0.75 \end{bmatrix}\begin{matrix} \\ \end{matrix}\begin{bmatrix} 35 \\ 45 \end{bmatrix}\begin{matrix} C \\ H \end{matrix}$$

E
$$\begin{matrix} & C & H \\ \end{matrix}\begin{bmatrix} 0.85 & 0.15 \\ 0.25 & 0.75 \end{bmatrix}\begin{matrix} \\ \end{matrix}\begin{bmatrix} 35 \\ 45 \end{bmatrix}\begin{matrix} C \\ H \end{matrix}$$

Question 7
The previous day the number of each drink sold would be given by the matrix (correct to the nearest whole drink):

A $\begin{bmatrix} 41 \\ 39 \end{bmatrix} \begin{matrix} C \\ H \end{matrix}$

B $\begin{bmatrix} 25 \\ 55 \end{bmatrix} \begin{matrix} C \\ H \end{matrix}$

C $\begin{bmatrix} 8 \\ 72 \end{bmatrix} \begin{matrix} C \\ H \end{matrix}$

D $\begin{bmatrix} 35 \\ 45 \end{bmatrix} \begin{matrix} C \\ H \end{matrix}$

E $\begin{bmatrix} 50 \\ 30 \end{bmatrix} \begin{matrix} C \\ H \end{matrix}$

Question 8
Assuming that the pattern continues indefinitely, which of the following statements is **not** true?

A In the long run the café will sell 20 more cappuccinos than hot chocolates to these customers each day.

B The steady state would have been the same regardless of how many customers bought each drink the first day

C Once the steady state is reached, the customers will continue to change their daily choice

D From a week after the first day, the total number of each type of drink sold (to the nearest whole number) will not change

E Any customer who buys a cappuccino the first day must have a hot chocolate eventually

Question 9

A farmer has sheep on two different farms. He moves the sheep between the farms for breeding purposes and each year there are a number of lambs born at each farm. The number of sheep on each farm A and B each year can be modelled by the following equation:

$$S_{n+1} = \begin{bmatrix} 0.82 & 0.26 \\ 0.18 & 0.74 \end{bmatrix} \times S_n + \begin{bmatrix} 120 \\ 30 \end{bmatrix} \text{ where } S_{2014} = \begin{bmatrix} 2000 \\ 3000 \end{bmatrix} \begin{matrix} A \\ B \end{matrix}$$

If the farmer wants the numbers of sheep to remain constant at each location from year to year he must:

A Sell 120 sheep from farm A and 30 sheep from farm B
B Sell 540 sheep from farm A and 390 sheep from farm B
C Sell 150 sheep from farm A and move an additional 625 sheep from farm A to farm B
D Sell 150 sheep from farm A and move an additional 390 sheep from farm A to farm B
E Buy 540 sheep for farm A and sell 390 sheep from farm B

END OF MULTIPLE - CHOICE QUESTION BOOKLET