TRIUMPH PUBLICATIONS

Fortify Sample Exam 1B

FURTHER MATHEMATICS

Written examination 1

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 – Core	24	24			20
B – Modules	32	16	4	2	16
					Total 40

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners, rulers, one bound reference, 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.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or correction fluid/tape.

Materials supplied
- Question book of 36 pages.
- Formula sheet
- Answer sheet for multiple-choice questions
- Working space is provided throughout the book.

Instructions
- Check that your **name** and **student number** as printed on your answer sheet for multiple-choice questions are correct, **and** sign your name in the space provided to verify this.
- Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

At the end of the examination
- You may keep the formula sheet.

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 - Core

Instructions

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 question.

Unless otherwise indicated, the diagrams in this book are **not** drawn to scale.

Data Analysis

Question 1

For a set of bivariate data that involves the variables x and y:

$$r = 0.71, \quad \bar{x} = 30.1, \quad \bar{y} = 180.1, \quad S_x = 2.6, \quad S_y = 13.0$$

Given the information above, the least squares regression line predicting y from x is closest to

A. $y = 3.6 + 73.2x$

B. $y = 175.8 + 0.14x$

C. $y = 175.8 - 0.14x$

D. $y = 73.2 - 3.6x$

E. $y = 73.2 + 3.6x$

Question 2

For a group of friends, the correlation constant between

- their time spent on Netflix and their general fitness is $r = -0.462$
- their time spent on Netflix and the number of tasty snacks they eat per week is $r = 0.679$

Given this information, which one of the following statements is true?

A. general fitness is more strongly associated with time spent on Netflix than number of tasty snacks eaten per week.

B. the number of tasty snacks eaten per week tends to decrease as time spent on Netflix increases.

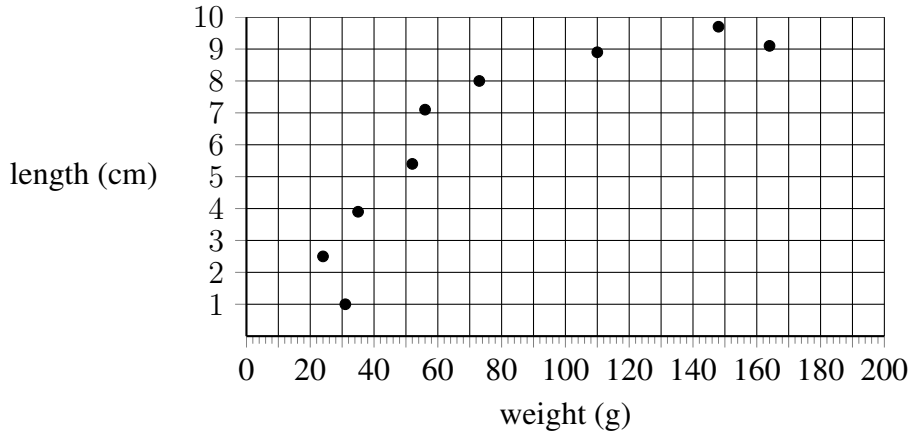
C. around 46.2% of the variation observed in general fitness can be explained by the variation in time spent on Netflix.

D. general fitness tends to decrease as time spent on Netflix increases.

E. the slope of a least squares regression line relating the number of tasty snacks eaten per week to time spent on Netflix is negative.

Question 3

The data in the scatterplot below shows the $length$, in cm, and the $weight$, in grams, of 9 bananas sampled from the same tree.



To linearise the scatterplot, $(length)^2$ is plotted against weight and a least squares regression line is then fitted to the linearised plot.

The equation of this least squares regression line is

$$(length)^2 = -2.3 + 0.6 \times (weight)$$

Using this equation, a banana with a weight of 200g is predicted to have a length in cm closest to

A. 10.2 **B.** 10.8

C. 11.1 **D.** 117.7

E. 122.3

Use the following information to answer Questions 4 and 5.

The height of skyscrapers in an area are approximately normally distributed with a mean height of 112.9 metres and a standard deviation of 18.5 metres.

Question 4

From this information it can be concluded that around 99.7% of the heights of the skyscrapers (in metres) should be between

A. 94.4 and 131.4 **B.** 94.4 and 149.9

C. 75.9 and 149.9 **D.** 75.9 and 168.4

E. 57.4 and 168.4

Question 5

A standardised skyscraper height of 0.8 corresponds to an actual skyscraper height of

A. 90.3 m **B.** 98.1 m

C. 102.6 m **D.** 112.9 m

E. 127.7 m

Question 6

A single back to back stem plot would be an appropriate graphical tool to investigate the association between an athlete's time to complete a marathon and the

A. number of marathons ran previously by the athlete

B. athlete's average speed, in kilometres per hour

C. athlete's smoker status (smoker/non-smoker)

D. athlete's diet type leading up to competing (carbohydrate-rich/protein-rich/vitamin-rich)

E. athlete's age, in years

Question 7

The seasonal index for skateboard sales during summer is 1.25.

To correct for seasonality, the skateboard sales figures for summer should be

A. reduced by 25%

B. reduced by 20%

C. increased by 20%

D. increased by 25%

E. increased by 125%

Question 8

The stem plot below displays the average number of pets per household from 27 towns.

key: 1|7 = 1.7

0	4
0	6 6 7 8 8 8 8 9
1	1 3 4
1	5 6 8 9 9 9
2	0 2 2 3 4
2	5 9
3	1 1

Based on this stem plot, the distribution of the average number of pets per household for these towns is best described as

A. negatively skewed with a median of 16 pets and a range of 27

B. positively skewed with a median of 16 pets and a range of 27

C. approximately symmetric with a median of 1.6 pets and a range of 2.7

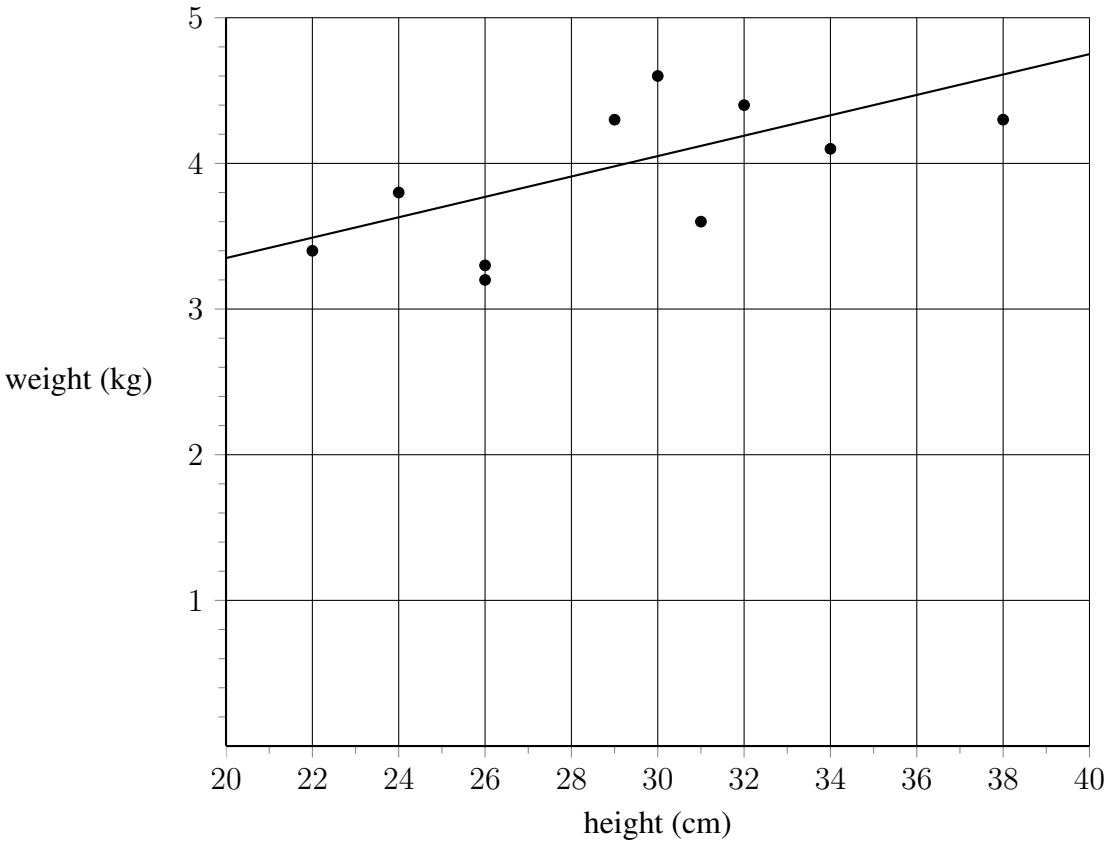
D. negatively skewed with a median of 1.6 pets and a range of 2.7

E. positively skewed with a median of 1.6 pets and a range of 2.7

Use the following information to answer Questions 9 - 11.

The $height$ (in cm) and $weight$ (in kg) of 10 cats were recorded and displayed in the scatterplot below.

A least squares regression line has been fitted to the data as shown.



Question 9

By inspection, the value of the product-moment correlation coefficient (r) is closest to

A. -0.64

B. -0.18

C. 0.18

D. 0.64

E. 0.91

Question 10

The explanatory variable is $height$.

The equation of the least squares regression line is closest to

A. $weight = 1.95 + 0.07 \times height$

B. $weight = -4.25 + 14.3 \times height$

C. $weight = 3.35 + 14.3 \times height$

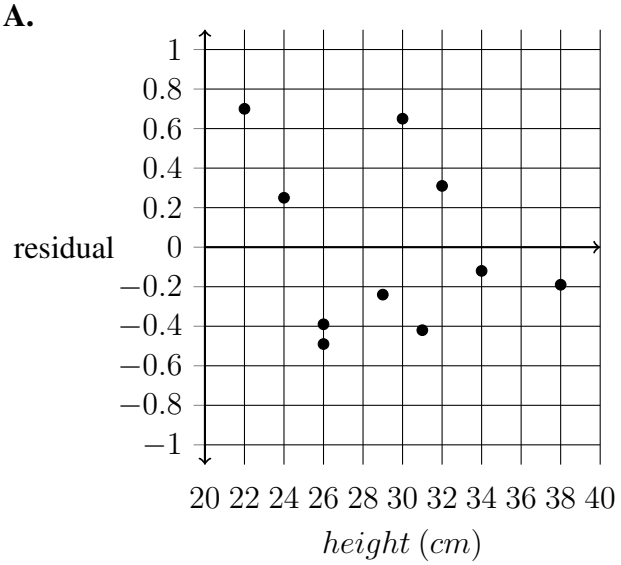
D. $weight = 3.35 + 0.07 \times height$

E. $height = 3.35 + 0.07 \times weight$

Question 11

The plot of $residuals$ against $height$ is closest to

A.



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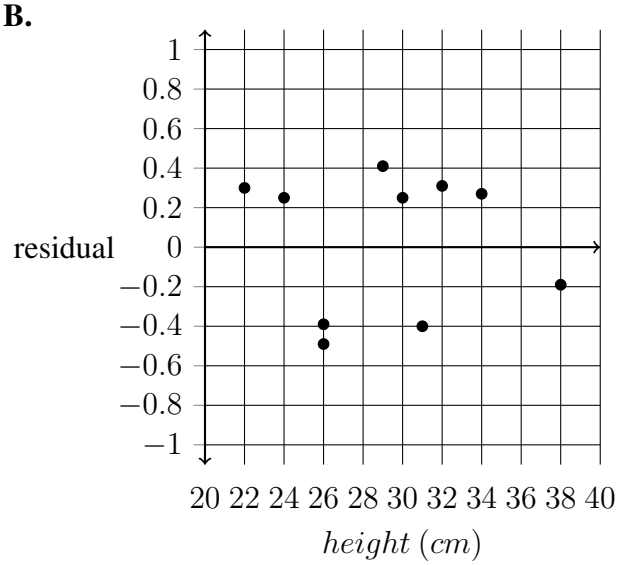
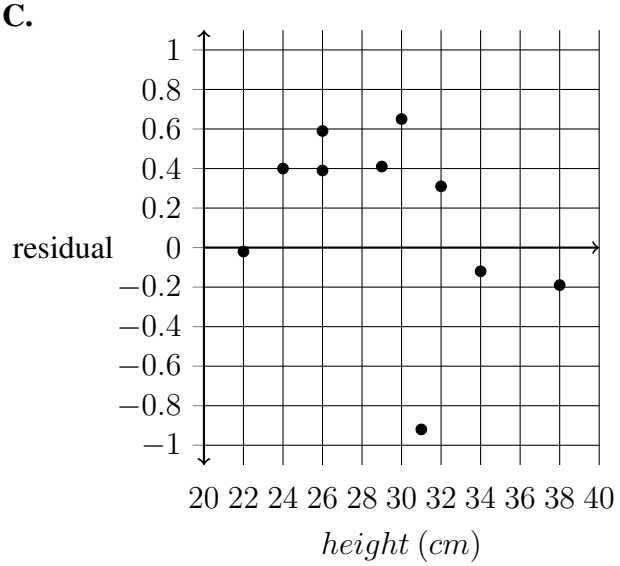
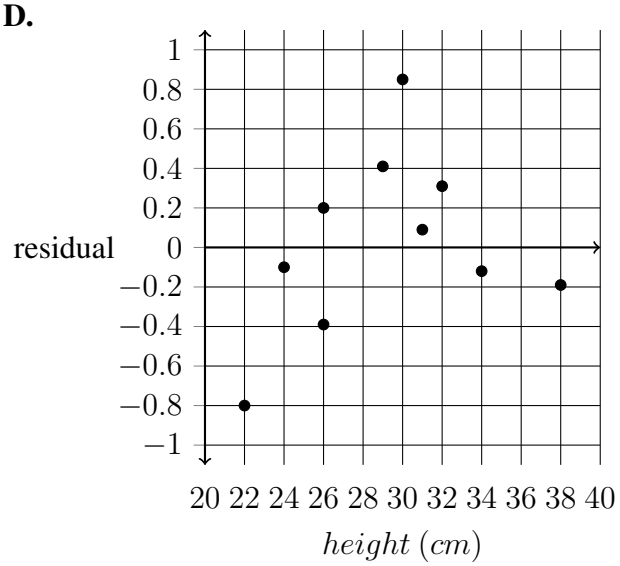


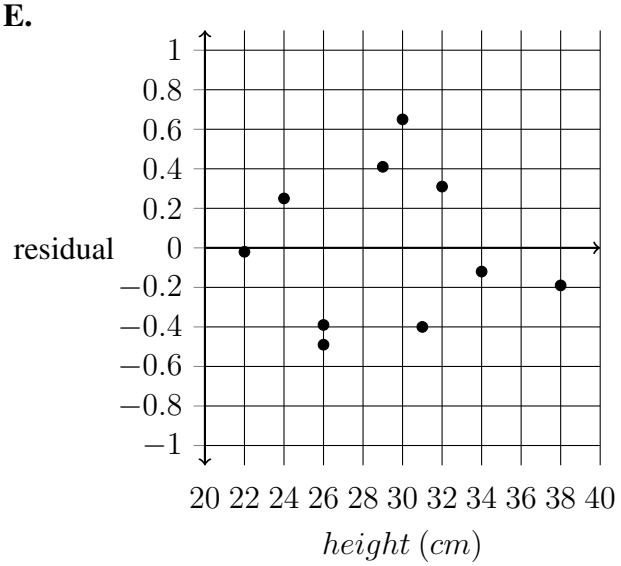
C.



D.

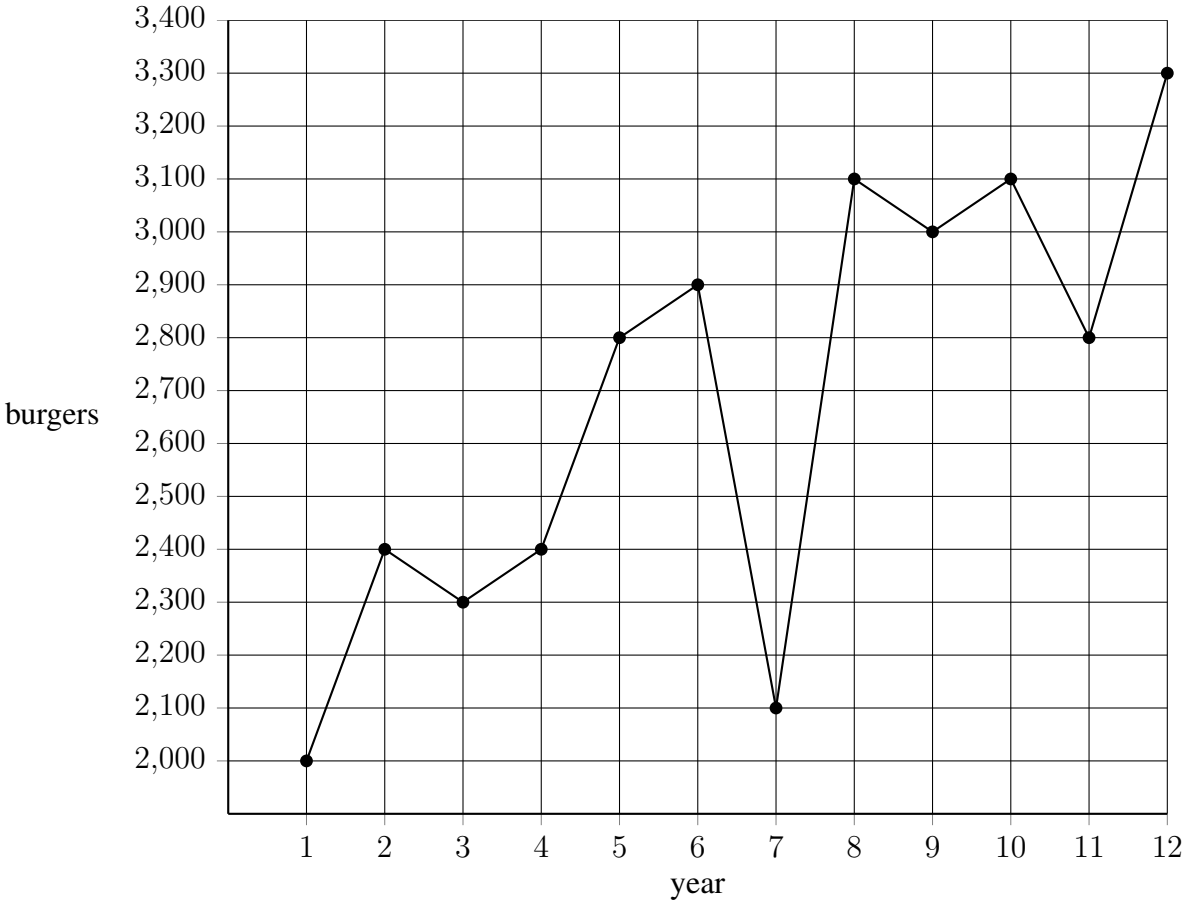


E.



Question 12

The time series plot below charts the number of burgers ordered per year from a takeaway store over a 12 year period.



Using five-mean smoothing, the smoothed number of burgers in year 7 was closest to

A. 2,100

B. 2,660

C. 2,780

D. 2,840

E. 2,900

Question 13

A beach-front store sells surfboards. The monthly seasonal indices of the revenue from the sale of surfboards are given below. The seasonal index for May is missing.

Seasonal Index											
Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
1.06	1.28	0.95	0.94		0.51	0.39	0.88	1.13	1.27	1.38	1.47

The revenue from the sale of surfboards in May 2016 was \$15,200.

The deseasonalised revenue for May 2016 is closest to

A. \$11,200 **B.** \$15,200

C. \$20,500 **D.** \$20,800

E. \$22,300

Question 14

The table below shows the commuting distance for 12 employees in a company in 2006 and 2016.

Employee	**Commute Distance (km)**	
	2006	**2016**
Stanley	13.32	13.62
Alexander	10.35	8.30
Michael	12.44	10.14
Lachlan	14.23	14.17
Jordan	12.91	9.59
Max	8.75	7.17
Rubi	10.47	5.46
Rebecca	11.14	3.88
Carly	8.62	5.13
Dylan	15.70	13.43
Jack	11.04	10.46
Jesse	10.08	6.72

The value of the correlation coefficient, r, for this set of data is closest to

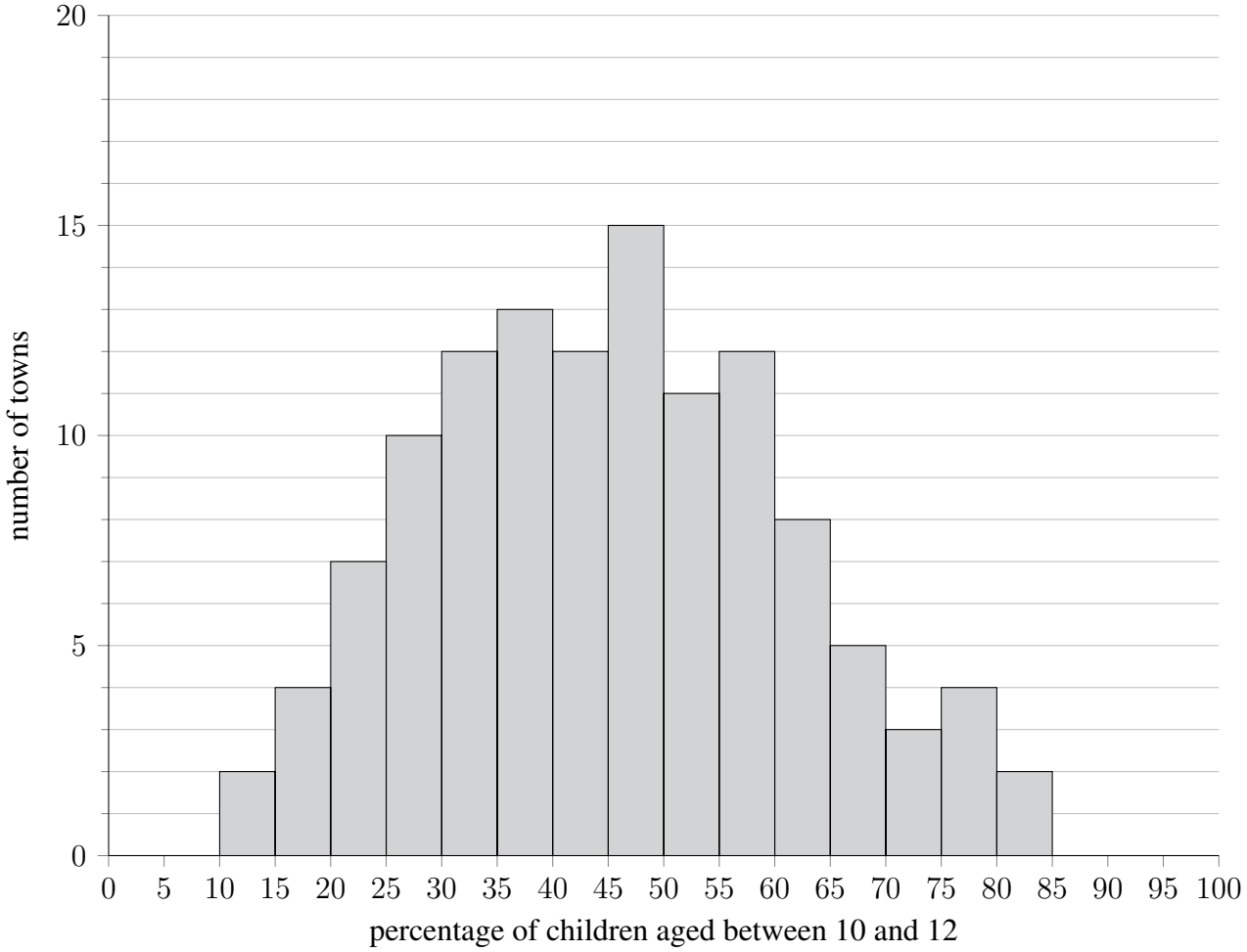
A. 0.66 **B.** 0.67

C. 0.81 **D.** 0.82

E. 0.90

Use the following information to answer Question 15 - 16.

The histogram below displays the distribution of the percentage of children aged between 10 and 12 who have their own smart phone in 120 towns in 2016.



Question 15

The shape of the histogram is best described as

A. uniform

B. bi-modal

C. approximately symmetric

D. positively skewed

E. negatively skewed

Question 16

The number of towns in which less than 25% of children aged between 10 and 12 have their own smartphone is closest to

A. 2

B. 4

C. 7

D. 11

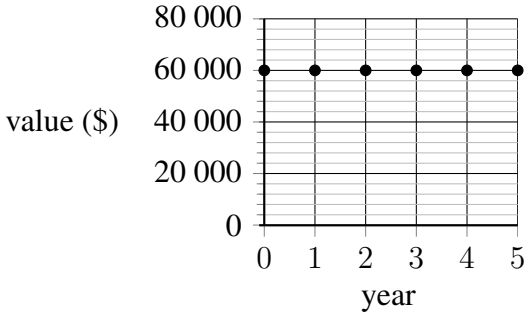
E. 13

Recursion and financial modelling

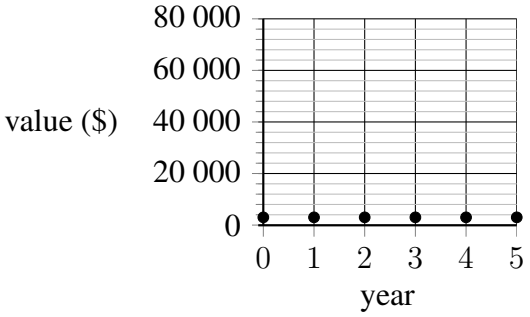
Question 17

Pablo invests $60,000 in a perpetuity that will provide $3,000 per year to fund an annual school service trip to Cambodia. The graph that shows the value of this perpetuity over a period of 5 years is

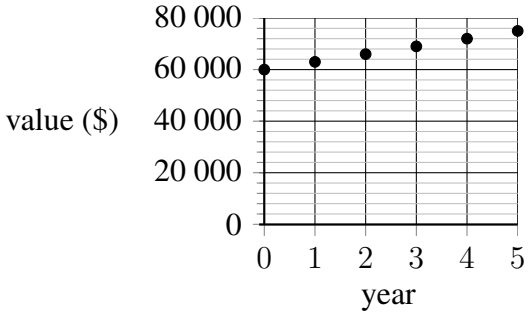
A.



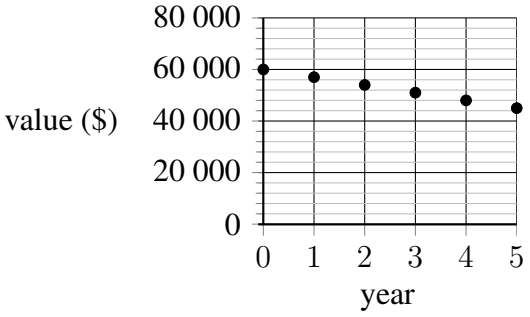
B.



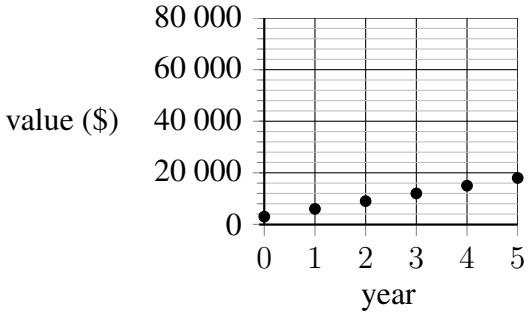
C.



D.



E.



Question 18

A beginner skateboarder aims to increase the height of his ollie by 5% each fortnight. The height of his ollie, O_n, in centimetres, after n fortnights, would be modelled by the rule

A. $O_{n+1} = 1.05 \times O_n$

B. $O_{n+1} = 1.5 \times O_n$

C. $O_{n+1} = 0.05 \times O_n$

D. $O_{n+1} = O_n + 5$

E. $O_{n+1} = O_n + 1.5$

Question 19

A bank approves a loan of $200,000 for a customer. The loan is to be repaid fully over 15 years in equal quarterly instalments. Interest is charged at a rate of 4.1% per annum calculated quarterly. To the nearest dollar the quarterly payment will be

A. $3,619
B. $4,074
C. $4,449
D. $4,479
E. $14,453

Question 20

Four lines of an amortisation table for an annuity investment are shown below. The interest rate for this investment remains constant, however payment value may vary.

Payment number	Payment amount	Interest	Principal addition	Balance of investment
21	150.00	31.55	181.55	10,700.80
22	150.00	32.10	182.10	10,882.90
23	150.00	32.65	182.65	11,065.55
24				11,300.00

The balance of the investment after payment number 24 is $11,300.00. The value of payment 24 is closest to

A. $33
B. $150
C. $201
D. $234
E. $272

Question 21

Four years after observations began, 10,568 bees were found to be living in a hive. The number of bees living in the hive changes from year to year according to the recurrence relation

$$B_{n+1} = 1.2B_n - 40, \qquad B_4 = 10\,568$$

where B_n is the number of bees observed living in the hive n years after observations began.

The number of bees living in the hive two years after observations began was closest to

A. 5,200
B. 6,200
C. 7,400
D. 8,840
E. 15,130

Question 22

Addison invests \$6,000 in a savings account that pays interest at a rate of 3.5% per annum compounding monthly. At the end of each month, immediately after the interest has been paid, Addison adds \$50 to his investment.

After 3 years, the value of his investment will be closest to

A. \$6,808 **B.** \$7,291

C. \$7,860 **D.** \$8,558

E. \$25,613

Question 23

A flamethrower is purchased for \$29,000. The value of the flamethrower is to be depreciated by 10% each year using the **reducing balance** method.

In the fourth year, the flamethrower will depreciate by

A. \$2,114.10 **B.** \$2,349.00

C. \$2,900.00 **D.** \$9,973.10

E. \$19,026.90

Question 24

Consider the recurrence relation below.

$$V_0 = 90\ 000, \qquad V_{n+1} = 1.05V_n - 4500$$

This recurrence relation could be used to model

A. a reducing balance loan with periodic payments of \$4,500

B. a reducing balance depreciation of an asset initially valued at \$90,000

C. an interest only loan of \$4,500

D. a perpetuity with periodic payments of \$4,500

E. an annuity investment with periodic additions of \$4,500 made to the investment

END OF SECTION A
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SECTION B - Modules

Instructions for Section B

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

Show the modules you 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.

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Contents **Page**

Module 1 - 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

Helga works full time. Each month, she spends part of her wage on necessities, and part of her wage on luxuries.

The matrix below shows how much she spends on necessities (N) and luxuries (L), in dollars, in each of three months.

$$\begin{array}{c} \\ \text{Month 1} \\ \text{Month 2} \\ \text{Month 3} \end{array} \begin{array}{c} \begin{array}{cc} N & L \end{array} \\ \begin{bmatrix} 3510 & 2340 \\ 3218 & 2632 \\ 3802 & 2048 \end{bmatrix} \end{array}$$

How much did Helga spend on necessities in Month 3?

A. \$2,048

B. \$2,340

C. \$3,218

D. \$3,510

E. \$3,802

Question 2

Four matrices are shown below.

$$A = \begin{bmatrix} 2 & 6 \\ 6 & 7 \\ 1 & 2 \end{bmatrix} \qquad B = \begin{bmatrix} 3 & 5 \\ 5 & 4 \end{bmatrix} \qquad C = \begin{bmatrix} 5 & 6 & 2 \\ 3 & 9 & 2 \end{bmatrix} \qquad D = \begin{bmatrix} 9 \\ 2 \end{bmatrix}$$

Which one of the following matrix products is **not** defined?

A. $A \times C$

B. $C \times A$

C. $B \times D$

D. $C \times D$

E. $B \times C$

Question 3

The matrix product $\begin{bmatrix} 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \times \begin{bmatrix} V \\ L \\ I \\ E \end{bmatrix}$ is equal to

A. $\begin{bmatrix} L \\ I \\ V \\ E \end{bmatrix}$ **B.** $\begin{bmatrix} V \\ E \\ I \\ L \end{bmatrix}$ **C.** $\begin{bmatrix} E \\ V \\ I \\ L \end{bmatrix}$ **D.** $\begin{bmatrix} L \\ E \\ I \\ V \end{bmatrix}$ **E.** $\begin{bmatrix} V \\ I \\ L \\ E \end{bmatrix}$

Question 4

Let $K = \begin{bmatrix} 4 & 3 & 2 & 1 \\ 7 & 6 & 5 & 4 \end{bmatrix}$

The element in Row m and Column n is k_{mn}.

The elements of K are determined by the rule

A. $k_{mn} = 2m + 2n$

B. $k_{mn} = m + n + 2$

C. $k_{mn} = 2m + n$

D. $k_{mn} = 3m - n + 2$

E. $k_{mn} = 3m - n + 1$

Question 5

$$x + z = 12$$
$$3y - z = 31$$
$$2x + 4y = -14$$

The system of three simultaneous linear equations above can be written in matrix form as

A. $\begin{bmatrix} 1 & 1 \\ 3 & -1 \\ 2 & 4 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 12 \\ 31 \\ -14 \end{bmatrix}$

B. $\begin{bmatrix} 1 & 0 & 1 \\ 0 & 3 & -1 \\ 2 & 4 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 12 \\ 31 \\ -14 \end{bmatrix}$

C. $\begin{bmatrix} 1 & 0 & 2 \\ 0 & 3 & 4 \\ 1 & -1 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 12 \\ 31 \\ -14 \end{bmatrix}$

D. $\begin{bmatrix} 1 & 3 & 2 \\ 1 & -1 & 4 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 12 \\ 31 \\ -14 \end{bmatrix}$

E. $\begin{bmatrix} 0 & 3 & -1 \\ 1 & 0 & 1 \\ 2 & 4 & 0 \end{bmatrix} \begin{bmatrix} x \\ y \\ z \end{bmatrix} = \begin{bmatrix} 12 \\ 31 \\ -14 \end{bmatrix}$

Question 6

Randy wants to egg the houses of five of his classmates, for his practical joke YouTube channel.
The five victims are Faith (F), Gianna (G), Hunter (H), Isaiah (I) and Joshua (J).
First up, Randy will egg Gianna's house.
Randy will use the transition matrix below to choose the order of his victims.
As soon as he has egged each victim's house once, his practical joke will be over.

$$\begin{array}{c} \\ F \\ G \\ H \\ I \\ J \end{array} \begin{array}{c} \textit{now} \\ \begin{array}{ccccc} F & G & H & I & J \end{array} \\ \left[\begin{array}{ccccc} 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 & 1 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \end{array}\right] \end{array} \begin{array}{l} \\ F \\ G \\ H \\ I \\ J \end{array} \quad \textit{next}$$

The order in which Randy eggs his next four victims' houses is

A. Joshua, Hunter, Faith, Isaiah

B. Joshua, Hunter, Faith, Gianna

C. Isaiah, Faith, Hunter, Gianna

D. Isaiah, Faith, Hunter, Joshua

E. Faith, Hunter, Gianna, Isaiah

Question 7

A group of Scouts are broken up into two units, competing against one another in the annual Scout BBQ Competition. The number of sausages, burgers and tofu sticks sold by each unit is shown in the table below.

Unit	Sausages	Burgers	Tofu Sticks
1	36	42	35
2	40	30	44

The sausages were sold for \$2.00 each, the burgers were sold for \$2.50 each, and the tofu sticks were sold for \$3.50 each.

A matrix product that can be used to calculate the amount, in dollars, raised by each unit by selling delicious BBQ food is

A. $\begin{bmatrix} 36 & 42 & 35 \\ 40 & 30 & 44 \end{bmatrix} \begin{bmatrix} 3.5 \\ 2.5 \\ 2 \end{bmatrix}$

B. $\begin{bmatrix} 1 & 36 & 42 & 35 \\ 2 & 40 & 30 & 44 \end{bmatrix} \begin{bmatrix} 3.5 \\ 2.5 \\ 2 \end{bmatrix}$

C. $\begin{bmatrix} 1 & 36 & 42 & 35 \\ 2 & 40 & 30 & 44 \end{bmatrix} \begin{bmatrix} 2 \\ 2.5 \\ 3.5 \end{bmatrix}$

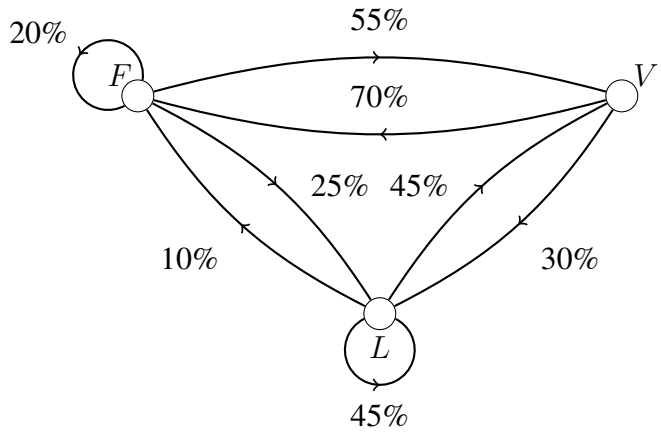
D. $\begin{bmatrix} 2 & 2.5 & 3.5 \end{bmatrix} \begin{bmatrix} 36 & 40 \\ 42 & 30 \\ 35 & 44 \end{bmatrix}$

E. $\begin{bmatrix} 2 & 2.5 & 3.5 \end{bmatrix} \begin{bmatrix} 35 & 44 \\ 42 & 30 \\ 36 & 40 \end{bmatrix}$

Question 8

Male students in a school were asked about their summer holidays. Every year these boys either spend most of their time playing video games (V), hanging out with their friends (F) or talking to potential lovers (L).

The transition diagram below shows the way male students in the school change the way they spend most of their summer holidays year to year.



A transition matrix that provides the same information as the diagram is

A.

$$\begin{array}{c} \quad\quad\ \textit{from} \\ \quad F \quad\ V \quad\ L \\ \begin{bmatrix} 0.20 & 0.15 & 0.35 \\ 0.15 & 0.50 & 0.75 \\ 0.35 & 0.75 & 0.45 \end{bmatrix} \begin{array}{l} F \\ V \ to \\ L \end{array} \end{array}$$

B.

$$\begin{array}{c} \quad\quad\ \textit{from} \\ \quad F \quad\ V \quad\ L \\ \begin{bmatrix} 0.10 & 0.45 & 0.45 \\ 0.70 & 0 & 0.30 \\ 0.20 & 0.55 & 0.25 \end{bmatrix} \begin{array}{l} F \\ V \ to \\ L \end{array} \end{array}$$

C.

$$\begin{array}{c} \quad\quad\ \textit{from} \\ \quad F \quad\ V \quad\ L \\ \begin{bmatrix} 0 & 0.10 & 0.25 \\ 0.20 & 0.55 & 0.70 \\ 0.45 & 0.45 & 0.30 \end{bmatrix} \begin{array}{l} F \\ V \ to \\ L \end{array} \end{array}$$

D.

$$\begin{array}{c} \quad\quad\ \textit{from} \\ \quad F \quad\ V \quad\ L \\ \begin{bmatrix} 0.20 & 0.70 & 0.10 \\ 0.55 & 0 & 0.45 \\ 0.25 & 0.30 & 0.45 \end{bmatrix} \begin{array}{l} F \\ V \ to \\ L \end{array} \end{array}$$

E.

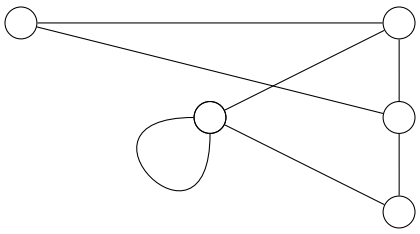
$$\begin{array}{c} \quad\quad\ \textit{from} \\ \quad F \quad\ V \quad\ L \\ \begin{bmatrix} 0.35 & 0.75 & 0.45 \\ 0.15 & 0.50 & 0.75 \\ 0.20 & 0.15 & 0.35 \end{bmatrix} \begin{array}{l} F \\ V \ to \\ L \end{array} \end{array}$$

Module 2 - 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

Consider the graph below.



The number of vertices of even degree in the graph above is

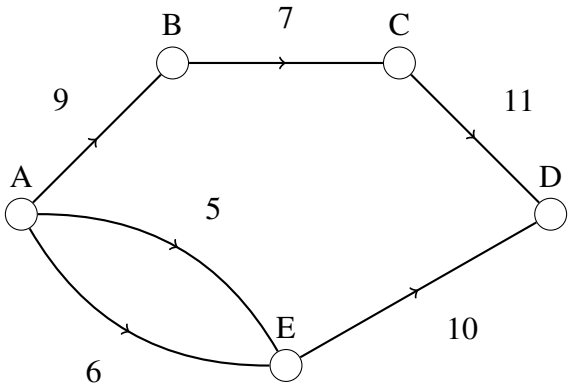
A. 1 **B.** 2

C. 3 **D.** 4

E. 5

Question 2

The following directed graph shows the maximum, one way capacity of roads connecting 5 towns, in cars per hour.



The maximum flow, in cars per hour from town A to town D is

A. 12 **B.** 17

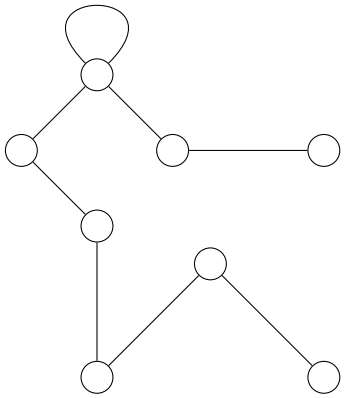
C. 19 **D.** 21

E. 22

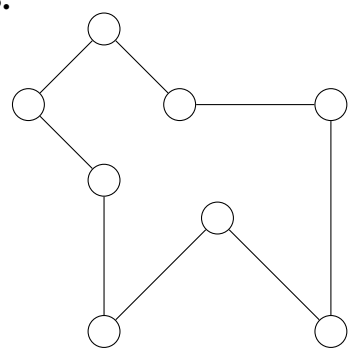
Question 3

Which one of the following graphs is a tree?

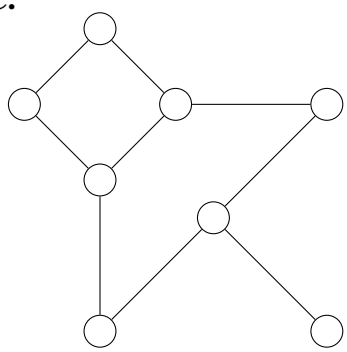
A.



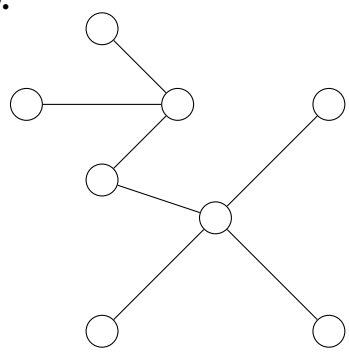
B.



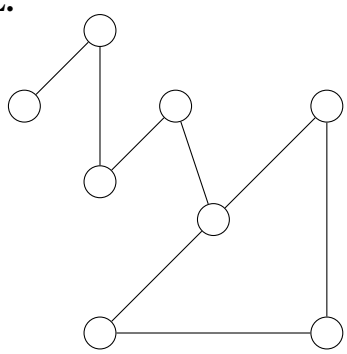
C.



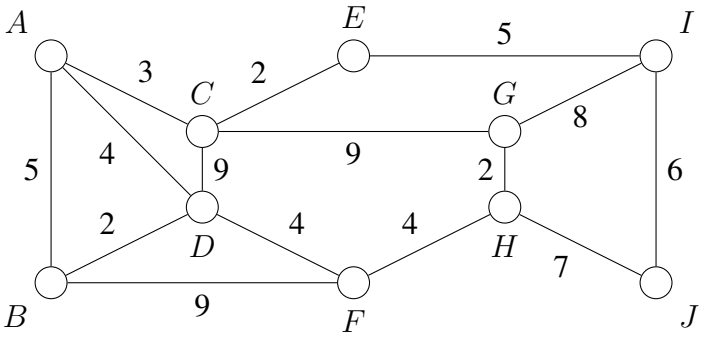
D.



E.

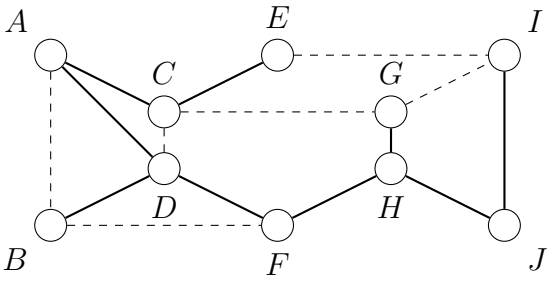


Question 4

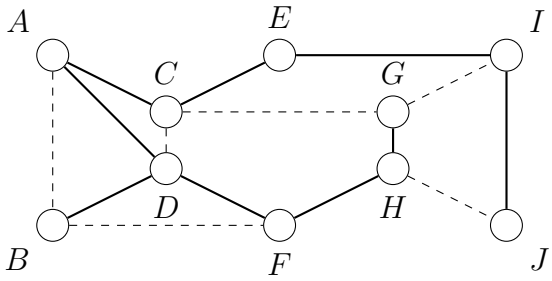


Which one of the following is the minimum spanning tree for the weighted graph shown above?

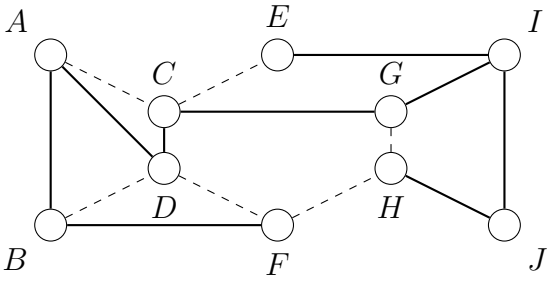
A.



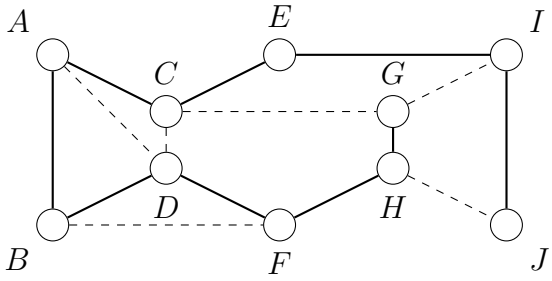
B.



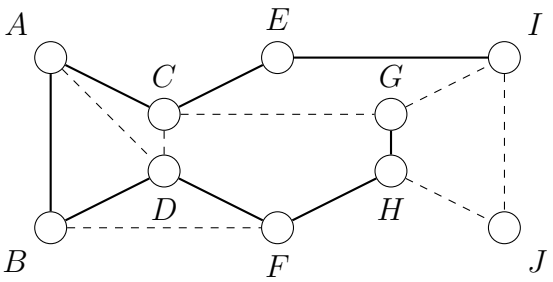
C.



D.

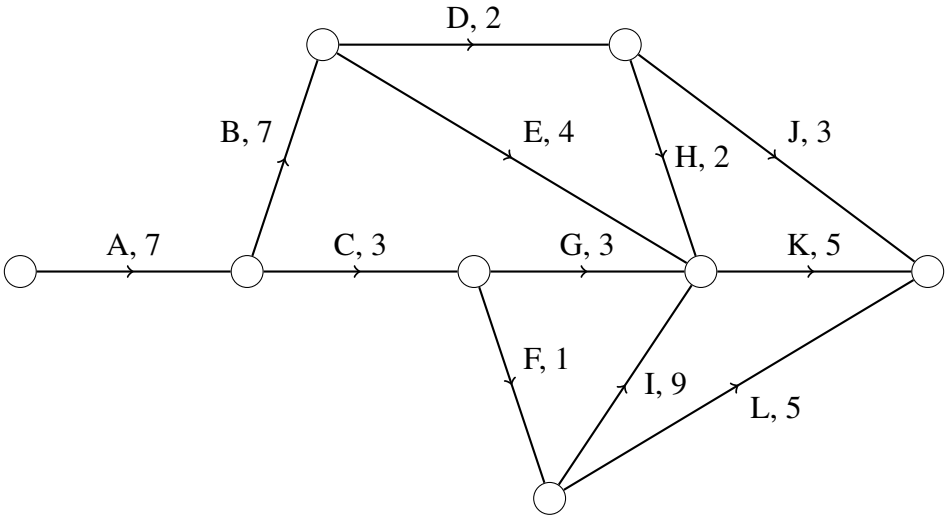


E.



Use the following information to answer Question 5 and 6.

The directed graph below shows the sequence of activities required to complete a project.
All times are in days.



Question 5

The number of activities that have exactly 1 predecessor is

A. 2

B. 5

C. 6

D. 10

E. 12

Question 6

There is one critical path for this project.
Three critical paths would exist if the duration of activity

A. C were increased by a day

B. H were increased by 2 days

C. I were reduced by 2 days

D. K were reduced by 2 days

E. L were reduced by 3 days

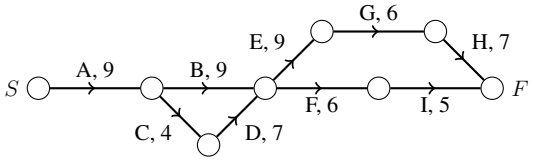
Question 7

The table below shows in weeks, the duration, the earliest starting time (EST) and the latest starting time (LST) of nine tasks needed to complete the construction of a house.

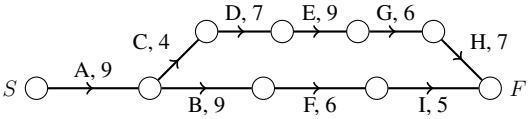
Activity	Duration	EST	LST
A	9	0	0
B	9	9	11
C	4	9	9
D	7	13	13
E	9	20	20
F	6	20	31
G	6	29	29
H	7	35	35
I	5	26	37

Which one of the following directed graphs shows the sequence of these activities?

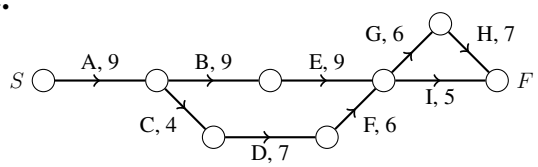
A.



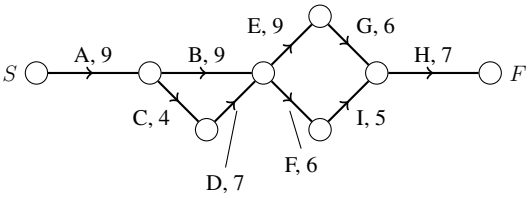
B.



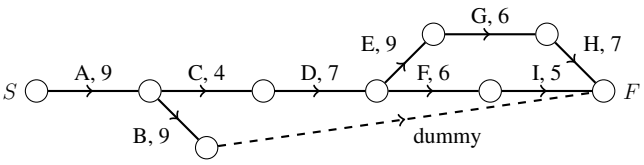
C.



D.



E.



Question 8

Four workers, Liam, Mike, Nathan and Olly are each to be allocated one of four jobs. Each person can complete each of the four jobs in a set time. These set times, in days, are shown in the table below.

	Liam	**Mike**	**Nathan**	**Olly**
Job 1	45	55	55	40
Job 2	50	35	30	50
Job 3	25	30	30	35
Job 4	45	30	40	25

If each person is allocated a different job, the minimum total time for these four people to complete these four jobs is

A. 120 days

B. 125 days

C. 130 days

D. 135 days

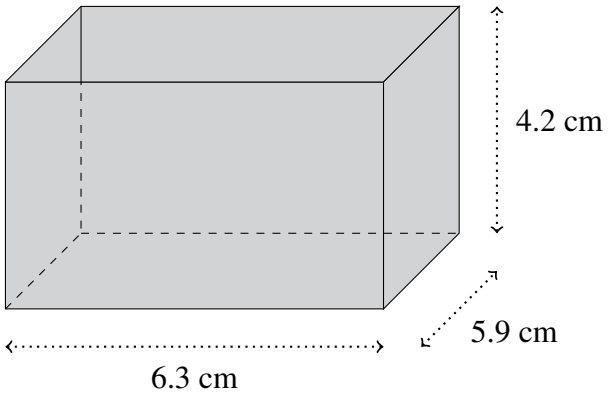
E. 140 days

Module 3 - Geometry and measurement

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

Question 1

A box of cardboard without a lid is constructed with a base length of 6.3 cm, width of 5.9 cm, and a height of 4.2 cm.



The surface area of the outside of this box, in square centimetres, is closest to

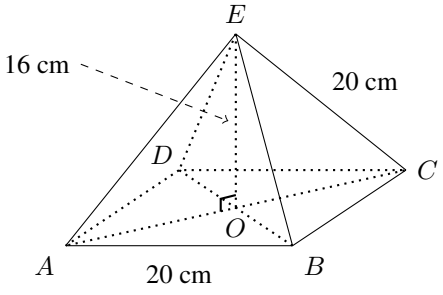
A. 177 **B.** 140

C. 156 **D.** 164

E. 152

Question 2

The diagram below shows a rectangular-based right pyramid, $ABCDE$.
In this pyramid, $AB = DC = AE = BE = CE = DE = 20$ cm, $OE = 16$ cm, and $AD = CB$.



The volume of this pyramid, in cubic centimetres, is closest to

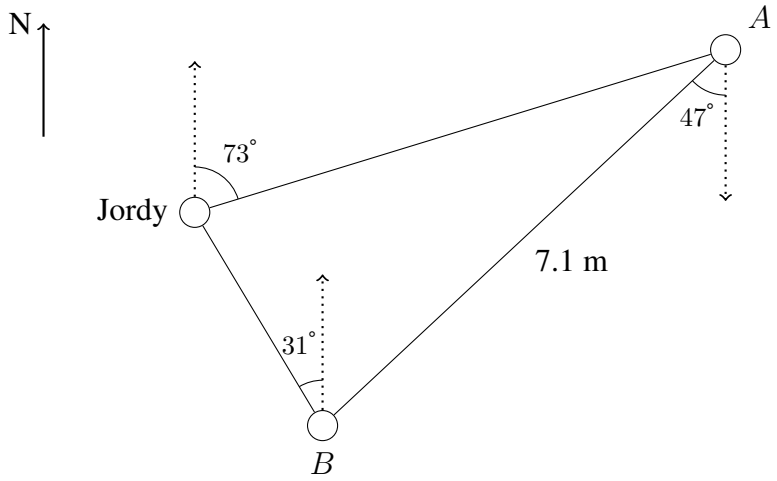
A. 1415 **B.** 265

C. 3332 **D.** 1707

E. 4245

Use the following information to answer Question 3 and 4.

Jordy is trying to find that special someone at a party. The positions of two other people, A and B, relative to Jordy, are presented below.



The direction of A from Jordy is N73°E.

The direction of B from A is S47°W.

The direction of Jordy from B is N31°W.

The distance from A to B is 7.1 metres.

Question 3

Jordy strikes out with person A, then goes to person B and strikes out with them, then returns to his original position, sad and dejected.

The distance, in metres, that Jordy travelled is closest to

A. 10.4 **B.** 17.5

C. 19.1 **D.** 19.2

E. 20.6

Question 4

Jordy wants to know the area within the triangle created by his path. This area, in square metres, is closest to

A. 11.1 **B.** 16.7

C. 20.2 **D.** 24.9

E. 37.8

Use the following information to answer Question 5 and 6.

Town A and Town B are in the same time zone.

Dan lives in Town A (0°, 80° W) and Brittany's Dojo, where he trains karate, is in Town B (0°, 93° W).

On one day in December, the sun will 'rise' in Town A at 5:54 am.

Question 5

Assuming that 15° of longitude equates to a one-hour time difference, the time that the sun is expected to 'rise' in Town B is

A. 5:02 am

B. 5:54 am

C. 6:07 am

D. 6:46 am

E. 6:54 am

Question 6

Dan owns a rocket car. On this particular day, Dan will leave Town A at sunrise to arrive at Town B at sunrise for training.

Assuming the radius of the Earth is 6,400 km, the minimum speed, in kilometres per hour, that Dan will have to drive his rocket car at to get to Brittany's Dojo at the desired time is closest to

A. 30

B. 1260

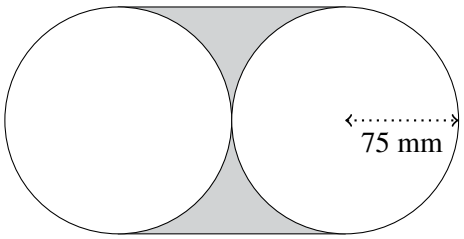
C. 1450

D. 1675

E. 1740

Question 7

Two circles of radius 75 mm are placed directly next to each other so that they are just touching.
A belt is wrapped around the circles, as shown below.



The area of the shaded region, in square centimetres, can be found by using the formula

A. $2 \times \pi \times 75^2$

B. $2 \times \pi \times 7.5^2$

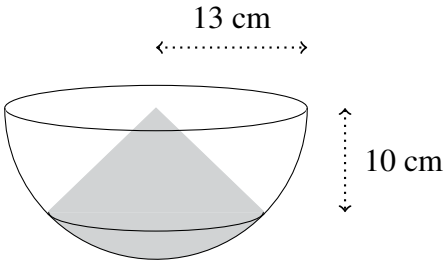
C. $150^2 - \pi \times 75^2$

D. $\left(\frac{150}{10}\right)^2 - \pi \times \left(\frac{75}{10}\right)^2$

E. $225 - 2 \times \pi \times 56.25$

Question 8

A hemispherical bowl of radius 13 cm is shown in the diagram below.
A cone and spherical cap are made by pouring sugar into the bowl. The cone has a height of 10 cm.



The volume of **just** the cone, in cubic centimetres, is closest to

A. 723

B. 1665

C. 2168

D. 2817

E. 2890

Module 4 - 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

The equation of the line that passes through the points $(5, 0)$ and $(5, 4)$ is

A. $y = 5x + 4$

B. $y = 4x + 5$

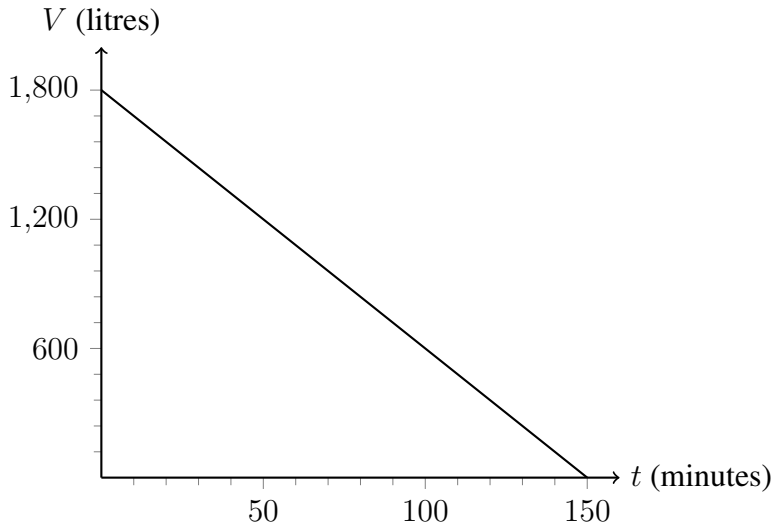
C. $y = 5x$

D. $y = 5$

E. $x = 5$

Question 2

A cement mixer holds 1,800 litres of cement. Cement is poured out at a constant rate.
The graph below shows how the volume of cement in the mixer, V, changes over time, t.



The constant rate, in litres per minute, at which cement is being poured out of the cement mixer is closest to

A. 0.08

B. 1.2

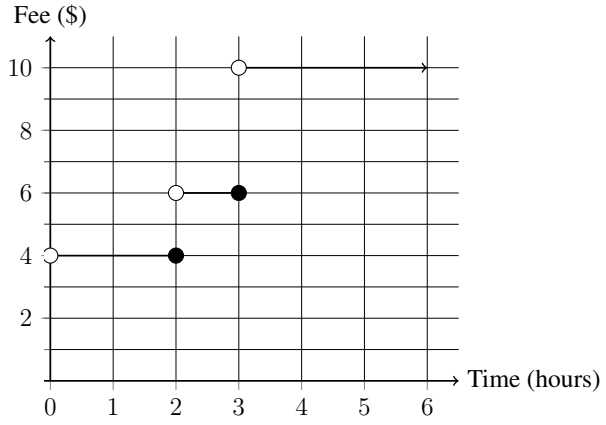
C. 12

D. 150

E. 720

Question 3

A public pool charges customers to use their lockers. The fee for use of a locker, in dollars, based on hours of use, is shown in the step graph below.



On a particular day:

- Three customers use the lockers for an hour
- One customer uses the lockers for three hours
- Two customers use the lockers for five hours

The total amount the public pool makes from locker fees on this day is

A. \$6

B. \$12

C. \$20

D. \$38

E. \$42

Question 4

A restaurant requires at least one waiter/waitress for every 7 tables seated.

Let x be the number of waiters/waitresses needed.

Let y be the number of tables seated.

Which one of the following is the inequality that represents this situation?

A. $y \leq 7x$

B. $y \geq \frac{x}{7}$

C. $y \geq 7x$

D. $7y \geq x$

E. $y \leq \frac{x}{7}$

Question 5

The snack bar at a cinema sells popcorn and soft drink.

- The Woodward family buys two popcorns and four soft drinks for $31.30
- The Hickson family buys three popcorns and three soft drinks for $33.15
- The Harrison family buys five popcorns and one soft drink

What is the total amount spent by the Harrison family?

A. $29.45 **B.** $31.30

C. $33.15 **D.** $35.20

E. $36.85

Question 6

In order to fund his passion, a surfer makes retro wetsuits and sells them on the beach.

The surfer pays $220 to cover his overheads. Each wetsuit costs $12 in materials and will be sold for $55.

To make a profit of at least $650, the minimum number of wetsuits the surfer will need to sell is

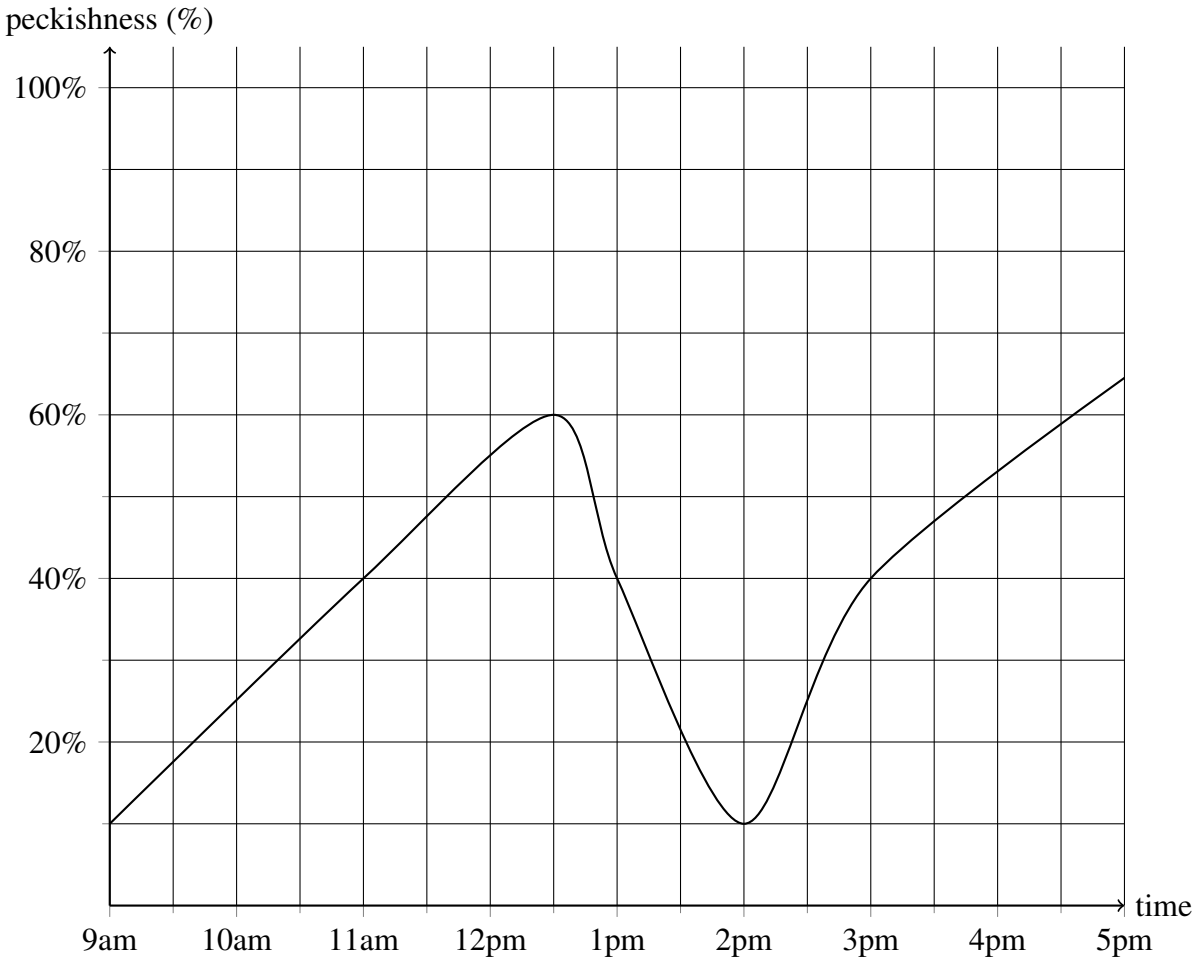
A. 11 **B.** 12

C. 16 **D.** 20

E. 21

Question 7

The graph below shows Mia's level of 'peckishness' over eight hours.



Over the eight-hour period, the length of time in hours, where Mia's 'peckishness' was over 40% is closest to

A. 1

B. 2

C. 3

D. 4

E. 5

Question 8

Xander and Yolandi are building a ramp for their bikes.

They must spend at least eight hours building the ramp.

Yolandi wants to do no more than twice as much work on the ramp than Xander.

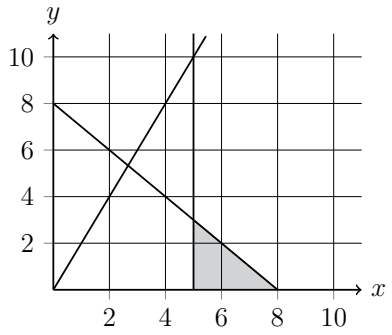
Xander doesn't want to spend more than five hours working on the ramp.

Let x represent the number of hours that Xander works on the ramp.

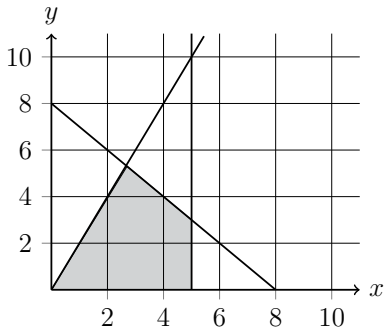
Let y represent the number of hours that Yolandi works on the ramp.

In which one of the following graphs does the shaded area show the feasible region defined by these conditions?

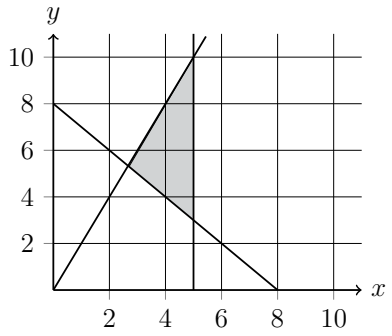
A.



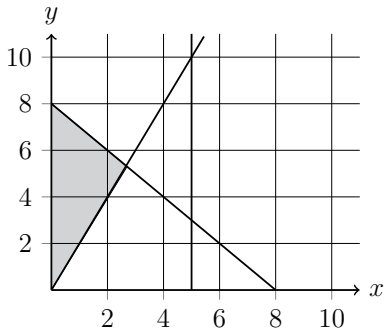
B.



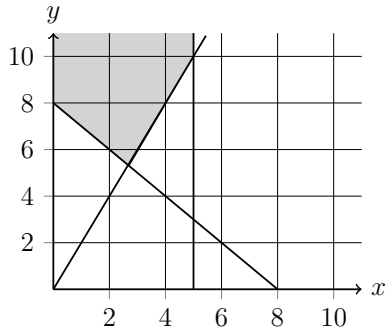
C.



D.



E.



END OF QUESTION AND ANSWER BOOK

TRIUMPH PUBLICATIONS

FURTHER MATHEMATICS

Written examination 1

FORMULA SHEET

Instructions

This formula sheet is provided for your reference.
A multiple-choice question book is provided with this formula sheet.

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

Formula Sheet

Core - Data Analysis

standardised score	$z = \dfrac{x - \bar{x}}{s_x}$
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 $b = r\dfrac{s_y}{s_x}$ and $a = \bar{y} - b\bar{x}$
residual value	residual value = actual value − predicted value
seasonal index	seasonal index $= \dfrac{\text{actual figure}}{\text{deseasonalised figure}}$

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	$r_{\text{effective}} = \left[\left(1 + \dfrac{r}{100n}\right)^n - 1\right] \times 100\%$

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	$A^{-1} = \dfrac{1}{\det A}\begin{bmatrix} d & -b \\ -c & a \end{bmatrix}$, where $\det A \neq 0$
recurrence relation	$S_0 =$ initial state, $S_{n+1} = TS_n + B$

Module 2 - Networks and Decision Mathematics

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

Module 3 - Geometry and Measurement

area of a triangle	$A = \frac{1}{2}bc\sin(\theta^\circ)$
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	$r \times \frac{\pi}{180} \times \theta^\circ$
area of a circle	πr^2
area of a sector	$\pi r^2 \times \frac{\theta^\circ}{360}$
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