2018 TRIAL EXAMINATION 1

UNITS 3&4

**STUDENT NAME**

| | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| First Name | | | | | | | | | | | | | | | | | | | |
| Last Name | | | | | | | | | | | | | | | | | | | |

# FURTHER MATHEMATICS

# Written examination 1

## 2018

**Reading time: 15 minutes**
**Writing time: 1 hour and 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 | | | 24 |
| 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 34 pages.
- Answer sheet for multiple-choice questions.
- Working space is provided throughout the book.

**Instructions**

- Write your **name** in the space provided above on this page.
- 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 – Core

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

## Data analysis

*Use the following information to answer Questions 1 and 2.*

The set of values given below represents the average number of marks, per game, for the AFL football teams in 2017.

83.1 84 84.5 85.6 87 89 90.8 90.9 90.9 93.2 94 94.6 96.4 99.5 103.4 104 104.3 105.7

Data: http://www.afl.com.au/stats 2017

**Question 1**

The five–number summary for this set of data is

**A.** 83.1 89 93.2 99.5 105.7
**B.** 83.1 85.6 92.05 103.4 105.7
**C.** 83.1 87 93.2 103.4 105.7
**D.** 83.1 87 92.05 99.5 105.7
**E.** 83.1 85.6 90.9 99.5 105.7

**Question 2**

This set of data has

**A.** no outliers.
**B.** one outlier to the left
**C.** one outlier to the right
**D.** one outlier on each side
**E.** two outliers to the left.

**Question 3**

A distribution has a mean of 48.2, a median of 47 and a mode of 45.
The shape of the distribution is

**A.** approximately normal.
**B.** symmetrical.
**C.** bell-shaped.
**D.** negatively skewed.
**E.** positively skewed.

*Use the following information to answer Questions 4 and 5.*

The two-way frequency table below displays the results of a survey regarding *Driving over the speed limit* (never, rarely, sometimes) and *Age* (under 30, over 30).

| | | *Driving over the speed limit* | | | |
|---|---|---|---|---|---|
| | | **never** | **rarely** | **sometimes** | **Total** |
| *Age* | **under 30** | 58 | 34 | 8 | 100 |
| | **over 30** | 96 | 39 | 5 | 140 |
| | **Total** | 154 | 73 | 13 | 240 |

**Question 4**

The variables *Age* and *Driving over the speed limit* are

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

**Question 5**

Which one of the following statements is **not** true?

**A.** Approximately 5.4% of all the people surveyed **sometimes** *drive over the speed limit*.
**B.** 240 people participated in this survey.
**C.** About 64% of all the people surveyed **never** *drive over the speed limit*.
**D.** 100 people **under 30** participated in this survey.
**E.** About 16% of the people **over 30 rarely** *drive over the speed limit*.

**Question 6**

Consider the five statements given below regarding linear associations between two numerical variables.

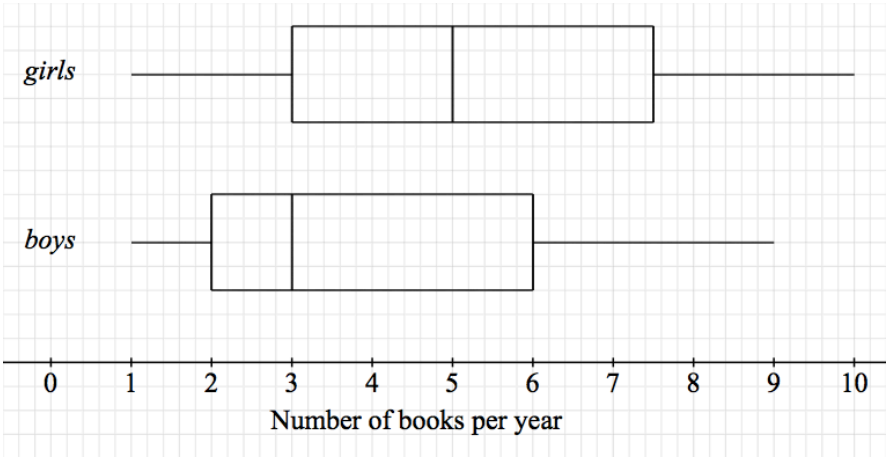
- The slope of a linear model indicates the change in the response variable per unit of the explanatory variable.
- A random scatterplot of the residuals indicates a non-linear model.
- The stronger the association between two variables is, the closer to 1 Pearson's correlation coefficient, $r$, is.
- A residual is the difference between the actual value and the predicted value of the response variable.
- The response variable is the variable on the horizontal axis.

How many of the statements above are **not** true?

**A.** 1
**B.** 2
**C.** 3
**D.** 4
**E.** 5

**Question 7**

The parallel boxplots shown below display the results in a survey regarding the *number of books* a group of students, *boys* and *girls*, read per year.




If 120 girls were surveyed, and the numbers of girls and boys who read less than 3 books per year is the same, then the number of boys surveyed is

**A.** 15
**B.** 30
**C.** 45
**D.** 60
**E.** 80

*Use the following information to answer Questions 8 and 9.*

A company manufactures metal rods. The diameter of a sample of 350 metal rods was measured and the data recorded.

The diameters were approximately normally distributed with a mean of 1 cm and a standard deviation of 0.05 cm.

**Question 8**

The percentage of these metal rods expected to have a diameter between 0.85 cm and 0.95 cm is closest to

**A.** 1.85%
**B.** 3.70%
**C.** 15.85%
**D.** 68.00%
**E.** 99.70%

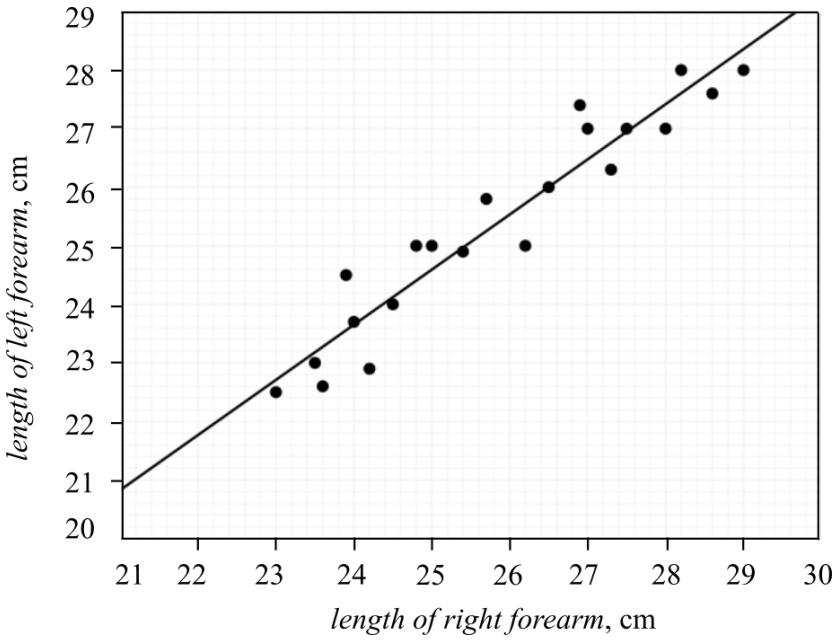
**Question 9**

If the standardised score of the diameter of one metal rod is $z = -1.6$, then the actual diameter of the metal rod is closest to

**A.** 0.08 cm
**B.** 0.92 cm
**C.** 0.95 cm
**D.** 1.05 cm
**E.** 1.08 cm

**Question 10**

In a study, the lengths, in cm, of the left and right forearms of 21 people were measured and the results displayed in a scatterplot as shown below. The least squares line was also fitted to the scatterplot.




Let $R$ be the *length of right forearm*.
Let $L$ be the *length of left forearm*.
Which one of the following equations best represents the least squares line above?

**A.** $L = 0.94 \times R + 1.06$
**B.** $L = 0.94 \times R + 20.9$
**C.** $R = 20.9 \times L + 1.06$
**D.** $R = 0.94 \times L + 20.9$
**E.** $L = 20.9 \times R + 1.06$

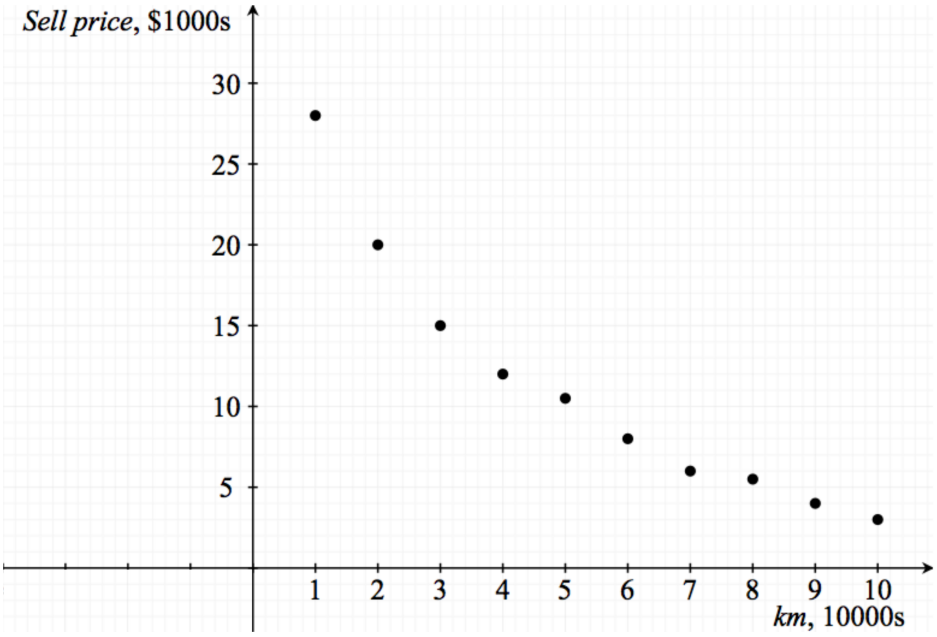
**Question 11**

For a given set of ordered pairs $(x, y)$, it was calculated that the standard deviation of the variable $x$ is $s_x = 7.9$ and the standard deviation of the variable $y$ is $s_y = 12.8$.
If the correlation coefficient $r = 0.72$, then the slope of the least squares line for this linear association is closest to

**A.** 0.44
**B.** 1.16
**C.** 1.17
**D.** 1.62
**E.** 2.25

**Question 12**

The value of a car decreases as the number of kilometres travelled increases. The selling price of a car is displayed on the scatter plot shown below for every 10000 km travelled.




Which one of the following transformations will **not** linearise this data?

**A.** $\log(y)$

**B.** $\log(x)$

**C.** $\frac{1}{x}$

**D.** $\frac{1}{y}$

**E.** $x^2$

*Use the following information to answer Questions 13 and 14.*

The revenue of a hairdressing salon on a Monday has a seasonal index of 0.68 while on a Thursday has a seasonal index of 1.35.

**Question 13**

To correct the Monday and Thursday revenues for seasonality, which one of the following statements is true?

**A.** The actual revenue for Monday should be increased by 47% while the actual revenue for Thursday should be decreased by 26%.

**B.** The actual revenue for Monday should be increased by 32% while the actual revenue for Thursday should be decreased by 35%.

**C.** The actual revenue for Monday should be increased by 68% while the actual revenue for Thursday should be decreased by 26%.

**D.** The actual revenue for Monday should be decreased by 47% while the actual revenue for Thursday should be increased by 26%.

**E.** The actual revenue for Monday should be decreased by 32% while the actual revenue for Thursday should be increased by 35%.

**Question 14**

If the revenue of the hairdressing salon on a Thursday was $1250, then the deseasonalised value of this revenue is closest to

**A.** $438

**B.** $813

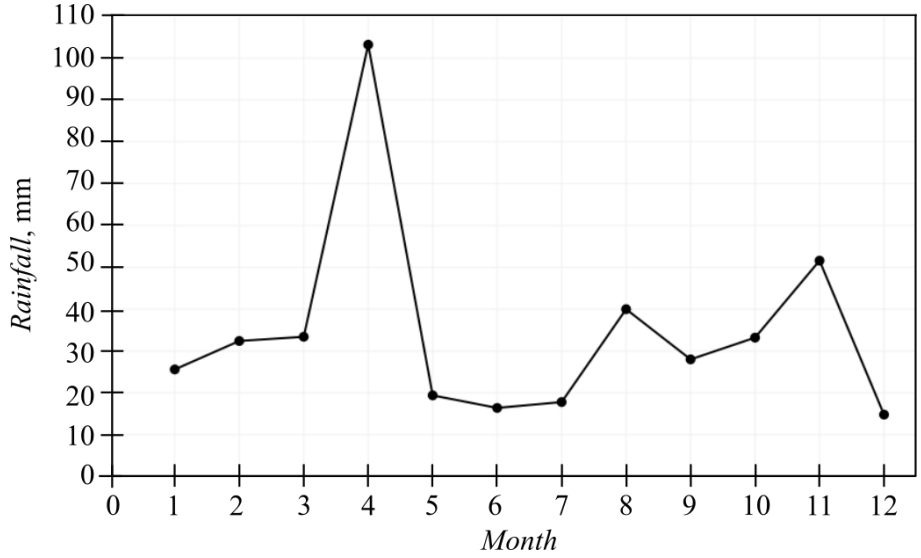
**C.** $926

**D.** $1575

**E.** $1688

*Use the following information to answer Questions 15 and 16.*

The time series below displays the monthly average *Rainfall* recorded over 12 months at a weather station.




**Question 15**

The time series above can be characterised as displaying

**A.** an irregular pattern.

**B.** an increasing trend with irregular pattern.

**C.** a decreasing trend with a seasonal pattern.

**D.** a seasonal pattern.

**E.** a decreasing trend only.

**Question 16**

If a five–point moving median is used to smooth this data, then the smoothed rainfall for month 9 is closest to

**A.** 20 mm

**B.** 29 mm

**C.** 33 mm

**D.** 40 mm

**E.** 50 mm

## Recursion and financial modelling

**Question 17**

Kelly deposits $800 in a new investment account. The first-order recurrence relation given below can be used to model the balance of this account at the end of each year, $n$, $n \geq 0$.

$$B_{n+1} = B_n + 28,\ B_0 = 800$$

Kelly's account could be a

**A.** simple interest account with an annual interest rate of 3.5%.
**B.** simple interest account with an annual interest rate of 7%.
**C.** compound interest account with an annual interest rate of 3.5%.
**D.** compound interest account with an annual interest rate of 7%.
**E.** compound interest account with an annual interest rate of 42% compounded monthly.

**Question 18**

The value of an asset, which was purchased for $50000, depreciates at a flat rate of $4000 per year. The future value of the asset, $V_n$, at the end of the year $n$, $n \geq 0$, can be calculated using the first-order recurrence relation

**A.** $V_{n+1} = V_n - 4000n,\ V_0 = \$50000$
**B.** $V_{n+1} = V_n - 4000,\ V_0 = \$50000$
**C.** $V_{n+1} = V_n + 4000,\ V_0 = \$4000$
**D.** $V_n = V_{n-1} + 4000n,\ V_0 = \$4000$
**E.** $V_n = V_{n+1} - 4000,\ V_0 = \$50000$

**Question 19**

A landscaper plants a 50 cm tall hedge at the front of a garden. He estimates that the hedge is going to grow at a rate of 0.4 metres per year. He trims the hedge at the end of each year by 30% of its height.
The height of the hedge after he trims it at the end of the third year is

**A.** $0.7^3 \times 0.9 + 0.7^2 \times 0.4 + 0.7 \times 0.4$
**B.** $0.7^3 \times 0.9$
**C.** $0.5 + 0.7^3 \times 0.4$
**D.** $0.7 \times 0.5 + 0.7^3 \times 0.4$
**E.** $0.7^3 \times 0.5 + 0.7^3 \times 0.4$

**Question 20**

A bank has two types of loans as shown below.

- Loan *A* charges interest at a rate of 5% per annum compounded weekly.
- Loan *B* charges interest at a rate of 8% per annum compounded yearly.

Hiba wants to borrow $15000 to purchase new equipment for her business.

The interest she would have to pay on this amount at the end of the first year on Loan *A* and Loan *B* respectively is closest to

**A.** $174 and $1245
**B.** $174 and $1236
**C.** $768 and $1200
**D.** $769 and $1200
**E.** $769 and $1236

**Question 21**

Owen borrows from a financial institution $460000 to purchase an apartment. The loan is a reducing balance home loan with an interest rate of 3.6% per annum compounded monthly. Owen makes monthly repayments on this home loan of $2500 to pay the monthly interest and to reduce the loan.

In the third month the loan will be reduced by

**A.** $1120
**B.** $1123
**C.** $1127
**D.** $2243
**E.** $3370

**Question 22**

Florina has $150000 to set up a perpetuity to pay some of her son's university fees. She needs to raise $2000 per term.

The annual interest rate of the perpetuity to ensure these funds are raised is closest to

**A.** 1.6%
**B.** 4.0%
**C.** 5.0%
**D.** 5.3%
**E.** 5.4%

**Question 23**

An annuity was set up to raise $21600 for an annual scholarship. The scholarship is going to be paid on equal monthly amounts.

It is known that the balance of the annuity after three years is $195201.33 at a rate of 6.4% per annum compounded monthly.

The amount invested in this annuity is closest to

**A.** $195956
**B.** $197454
**C.** $215054
**D.** $204000
**E.** $220000

**Question 24**

Sean borrowed $120000 at an interest rate of 3.8% per annum compounded monthly.

Which one of the following statements is **not** true for this loan?

**A.** The loan will be fully repaid in about 3 years if the monthly repayments are $3530.
**B.** If the monthly repayments are $2500, then Sean will owe about $39295 at the end of the 3rd year.
**C.** Monthly repayments of $2700 will increase the life of the loan to about 4 years.
**D.** A monthly payment of $6201 will increase the life of the loan to about 20 years.
**E.** If the first monthly payment is $3530, the loan will be reduced by about $3150 in the first month.

**END OF SECTION A**
**TURN OVER**

Working space

# SECTION B

**Instructions for Section B**

Select **two** 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 question.

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# 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**

In the equation $mA + nB = I$, $m$ and $n$ are two real non-zero constants and $A$ and $B$ are two matrices as shown below.

$$A = \begin{bmatrix} -1 & 4 \\ 2 & -1 \end{bmatrix} \qquad B = \begin{bmatrix} -2 & 6 \\ 3 & -2 \end{bmatrix}$$

$I$ is the $2 \times 2$ identity matrix.

The values of $m$ and $n$ are respectively

**A.** $m = -3$ and $n = 2$

**B.** $m = 2$ and $n = -3$

**C.** $m = 3$ and $n = -2$

**D.** $m = -2$ and $n = 3$

**E.** $m = -2$ and $n = -2$

**Question 2**

Let $a_{ij}$ be the element in row $i$ and column $j$ in the $3 \times 3$ matrix $A$, with rule $a_{ij} = i - 2j$.

Let $b_{ij}$ be the element in row $i$ and column $j$ in the $3 \times 3$ matrix $B$, with rule $b_{ij} = 2i + j$.

The value of $2a_{23} + 3b_{23}$ is

**A.** –21

**B.** –8

**C.** –4

**D.** 7

**E.** 13

**Question 3**

Let $C$ and $D$ be two square matrices of order $n \times n$.

The expression $(C + D)(C - D)$ is equivalent to

**A.** $C^2 - D^2$

**B.** $C^2 + D^2$

**C.** $C^2 + 2DC - D^2$

**D.** $C^2 - 2CD - D^2$

**E.** $C^2 - CD + DC - D^2$

**Question 4**

A shop sells two types of footwear: *boots*, *B*, and *shoes*, *S*.
In *July* the shop sold 28 pairs of *boots* and 35 pairs of *shoes*.
In *August* the shop sold 37 pairs of *boots* and 42 pairs of *shoes*.
The matrix, *M*, below shows the numbers of *boots* and *shoes* sold in *July* and *August*.

$$M = \begin{matrix} \\ July \\ August \end{matrix} \begin{matrix} \begin{matrix} B & S \end{matrix} \\ \begin{bmatrix} 28 & 35 \\ 37 & 42 \end{bmatrix} \end{matrix}$$

On average, a pair of *boots* costs \$120 and a pair of *shoes* costs \$75.
Which one of the following expressions can be used to calculate the sales amounts in the two months?

**A.** $\begin{bmatrix} 28 & 35 \\ 37 & 42 \end{bmatrix} . \begin{bmatrix} 120 \\ 75 \end{bmatrix}$

**B.** $\begin{bmatrix} 120 \\ 75 \end{bmatrix} . \begin{bmatrix} 28 & 35 \\ 37 & 42 \end{bmatrix}$

**C.** $\begin{bmatrix} 120 & 75 \end{bmatrix} . \begin{bmatrix} 28 & 35 \\ 37 & 42 \end{bmatrix}$

**D.** $\begin{bmatrix} 28 & 35 \\ 37 & 42 \end{bmatrix} . \begin{bmatrix} 120 & 75 \end{bmatrix}$

**E.** $\begin{bmatrix} 28 & 35 \\ 37 & 42 \end{bmatrix} + \begin{bmatrix} 120 & 75 \end{bmatrix}$

**Question 5**

Consider the four matrix equations given below.

$$\begin{bmatrix} 3 & 0 \\ 1 & -2 \end{bmatrix} . \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -1 \\ 2 \end{bmatrix} \quad \begin{bmatrix} 6 & 2 \\ -3 & -1 \end{bmatrix} . \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} -10 \\ 5 \end{bmatrix} \quad \begin{bmatrix} -1 & 5 \\ 0 & 1 \end{bmatrix} . \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3 \\ -4 \end{bmatrix}$$

$$\begin{bmatrix} 7 & 2 \\ -14 & -4 \end{bmatrix} . \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 3 \\ -1 \end{bmatrix}$$

The number of systems of matrix equations with an unique solution is

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

**Question 6**

Consider the permutation matrix $P = \begin{bmatrix} 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix}$.

Which one of the following statements is **not** true for matrix $P$?

**A.** Matrix $P$ can be used to change $\begin{bmatrix} S \\ T \\ E \\ A \\ M \end{bmatrix}$ to $\begin{bmatrix} M \\ A \\ T \\ E \\ S \end{bmatrix}$.

**B.** The inverse matrix $P^{-1} = \begin{bmatrix} 0 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 \end{bmatrix}$.

**C.** Matrix $P$ can be used to change $\begin{bmatrix} S \\ T \\ E \\ A \\ M \end{bmatrix}$ to $\begin{bmatrix} M \\ E \\ A \\ T \\ S \end{bmatrix}$.

**D.** The transpose matrix $P^T = P^{-1}$

**E.** Matrix $P$ is a binary matrix.

**Question 7**

Consider the matrix recurrence equation $M_{n+1} = TM_n + A$, where matrices $T$, $M_0$, and $A$ are as defined below.

$$T = \begin{bmatrix} 0.24 & 0.15 & 0 \\ 0 & 0.36 & 0.72 \\ 0.76 & 0.49 & 0.28 \end{bmatrix}, \; M_0 = \begin{bmatrix} 1200 \\ 850 \\ 950 \end{bmatrix} \text{ and } A = \begin{bmatrix} 300 \\ 400 \\ 500 \end{bmatrix}$$

Using this information, matrix $M_3$ is equal to

**A.** $\begin{bmatrix} 715.5 \\ 1390.0 \\ 294.5 \end{bmatrix}$

**B.** $\begin{bmatrix} 585.24 \\ 1839.68 \\ 1775.08 \end{bmatrix}$

**C.** $\begin{bmatrix} 680.22 \\ 2408.44 \\ 2311.34 \end{bmatrix}$

**D.** $\begin{bmatrix} 824.52 \\ 2931.2 \\ 2844.28 \end{bmatrix}$

**E.** $\begin{bmatrix} 1185.24 \\ 2639.68 \\ 2775.08 \end{bmatrix}$

**Question 8**

In an international mathematics competition four students from four different countries, $A$, $B$, $C$ and $D$, made it to the finals. In the finals each student had to compete against each of the other three students.

The results of the competition are as follows:

- $A$ defeated $B$ but lost against $C$
- $B$ defeated $C$ but lost against the other competitors
- $D$ lost against $C$ and $A$

These results are represented in a matrix, **M**, where element 1 represents a win for the student in that row against the student in that column and element 0 in the matrix represents a loss for the student in that row against the student in that column.

Which one of the following matrices is matrix **M**?

**A.**

$$\begin{array}{c} \\ win \end{array} \begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{bmatrix} 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix} \end{array} \begin{array}{l} A \\ B \\ C \\ D \end{array}$$

*loss*

**B.**

$$\begin{array}{c} \\ win \end{array} \begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{bmatrix} 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \end{bmatrix} \end{array} \begin{array}{l} A \\ B \\ C \\ D \end{array}$$

*loss*

**C.**

$$\begin{array}{c} \\ win \end{array} \begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{bmatrix} 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 \end{bmatrix} \end{array} \begin{array}{l} A \\ B \\ C \\ D \end{array}$$

*loss*

**D.**

$$\begin{array}{c} \\ win \end{array} \begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{bmatrix} 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 \\ 0 & 1 & 0 & 1 \end{bmatrix} \end{array} \begin{array}{l} A \\ B \\ C \\ D \end{array}$$

*loss*

**E.**

$$\begin{array}{c} \\ win \end{array} \begin{array}{c} \begin{array}{cccc} A & B & C & D \end{array} \\ \begin{bmatrix} 0 & 1 & 0 & 1 \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 1 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix} \end{array} \begin{array}{l} A \\ B \\ C \\ D \end{array}$$

**END OF MODULE 1**
**SECTION B** – continued
**TURN OVER**

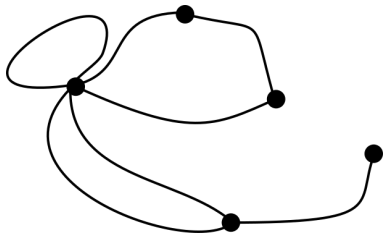
Working space

# 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 shown in the diagram below.



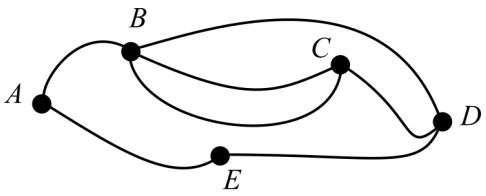
Which one of the following statements is **not** true for this graph?

**A.** The graph is connected.
**B.** The graph has three vertices of even degrees and two vertices of odd degrees.
**C.** The graph has four faces and seven edges.
**D.** The graph is planar.
**E.** The graph has one isolated vertex.

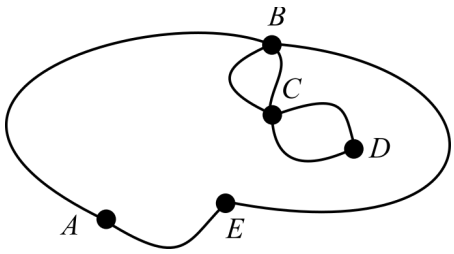
**Question 2**

Which one of the following graphs has at least one hamiltonian cycle but **not** an eulerian circuit?

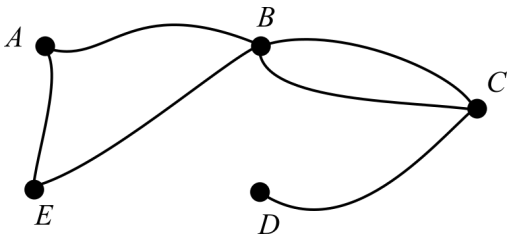
**A.**



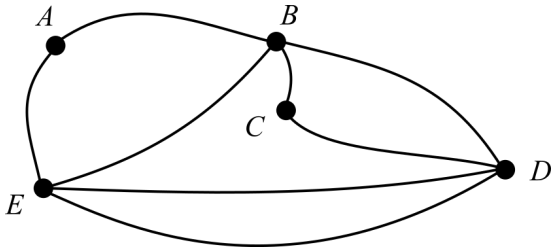

**B.**



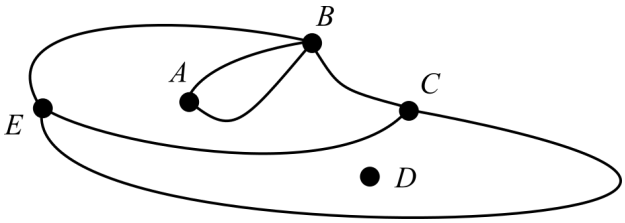

**C.**




**D.**




**E.**



**Question 3**

In a family with five siblings the house chores are given to each child depending on their age. There are five house chores: setting up the table, *T*, washing the dishes, *W*, vacuuming, *V,* mowing the lawn, *M*, and washing the dog, *D*.

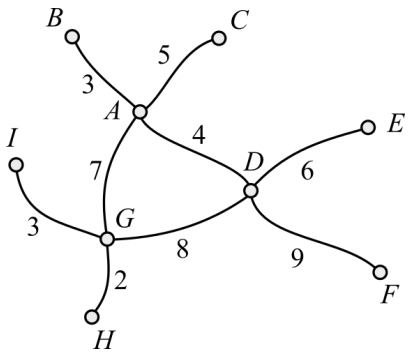
- Laura is the oldest sibling so she can do any of these house chores.
- Mason is the youngest and can only set up the table.
- Nigel is not allowed to mow the lawn or vacuum because he is not old enough.
- Olivia can only set up the table and wash the dishes.
- Pamela is not allowed to mow the lawn because she is not old enough to control the lawn mower.

Which one of the siblings is going to wash the dog?

**A.** Laura
**B.** Mason
**C.** Nigel
**D.** Olivia
**E.** Pamela

*Use the following information to answer Questions 4 and 5.*

The graph below represents a network of computers connected to each other. The number on an edge represents the length of the connecting cord between two computers.




**Question 4**

The maximum number of spanning trees in this network is

**A.** 1
**B.** 2
**C.** 3
**D.** 4
**E.** 5

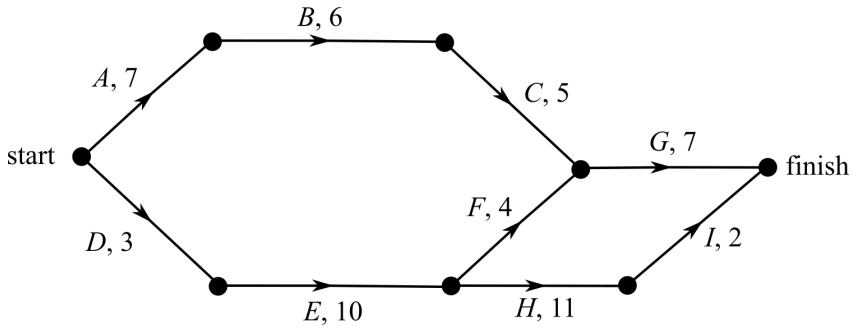
**Question 5**

The minimum length of cord needed to connect the nine computers is

**A.** 39 metres
**B.** 40 metres
**C.** 41 metres
**D.** 42 metres
**E.** 43 metres

*Use the following information to answer Questions 6 and 7.*

Consider the directed graph below, which represents a series of activities required to be completed during a renovation project. The times of the activities are given in days.




**Question 6**

The latest starting time for activity *G* in order to satisfy the conditions for the shortest duration of this project is

**A.** 14 minutes
**B.** 15 minutes
**C.** 18 minutes
**D.** 19 minutes
**E.** 26 minutes

**Question 7**

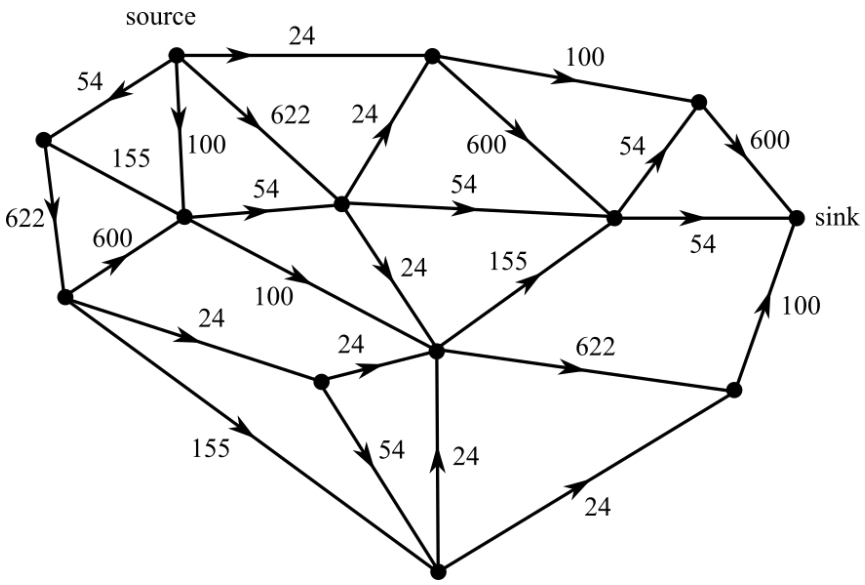
The project manager realised that activity *G* requires an extra day to be completed. This will change the completion time for activity *G* to 8 days.

Increasing activity *G* to 8 days means that the project will have

**A.** a different critical path, *A*-*B*-*C*-*G*.
**B.** two critical paths, *A*-*B*-*C*-*G* and *D*-*E*-*H*-*I*.
**C.** a new critical path, *D*-*E*-*F*-*G*.
**D.** the same critical path as originally calculated.
**E.** a new critical path, *A*-*B*-*C*-*F*-*H*-*I*.

**Question 8**

The vertices in the diagram below represent modems connected in an internet network. The number on each edge represents the maximum amount of data that can be transmitted between the two modems connected in megabits per second.




The minimum cut crosses $n$ edges and the maximum flow is $m$.

The values of $n$ and $m$ are respectively

**A.** $n = 4$ and $m = 308$

**B.** $n = 5$ and $m = 357$

**C.** $n = 6$ and $m = 356$

**D.** $n = 7$ and $m = 274$

**E.** $n = 8$ and $m = 298$

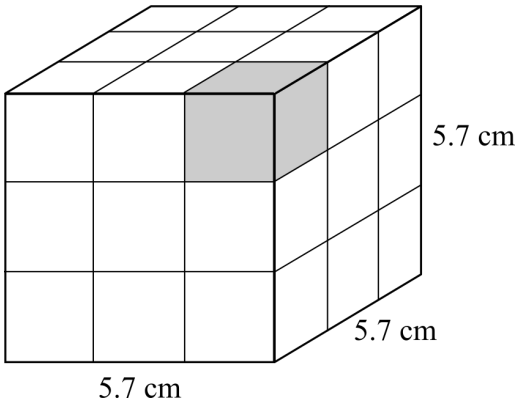
**END OF MODULE 2**
**SECTION B** – continued

# 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.

*Use the following information to answer Questions 1 and 2.*

The Rubik's cube is a three-dimensional toy in the shape of a cube with a sidelength of 5.7 cm as shown in the diagram below. The cube is made up of 26 identical smaller cubes and a turning device in the middle of the cube that takes the space of one small cube.




**Question 1**

The length of the side of the smaller cube is

**A.** 1.9 cm
**B.** 2.0 cm
**C.** 2.1 cm
**D.** 2.5 cm
**E.** 2.7 cm

**Question 2**

Let $V$ be the volume of the Rubik's cube. The volume occupied by the turning device can be calculated using the expression

**A.** $\frac{1}{3}V$

**B.** $\frac{1}{26}V$

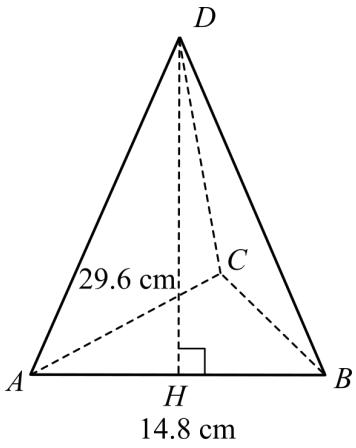
**C.** $\frac{1}{9}V$

**D.** $\frac{1}{27}V$

**E.** $\frac{26}{27}V$

*Use the following information to answer Questions 3 and 4.*

Consider the regular triangular pyramid, *ABCD*, shown in the diagram below. The base triangle, *ABC*, is an equilateral triangle and the three triangles, *ABD*, *ACD* and *BCD*, are isosceles triangles where *AD*, *BD* and *CD* are equal sides. The length of the base, *AB*, of the triangular face *ABD* is 14.8 cm and its height, *DH*, is 29.6 cm.




**Question 3**

The length of the slant, *BD*, of the triangular pyramid, correct to one decimal place, is closest to

**A.** 20.6 cm
**B.** 20.9 cm
**C.** 25.6 cm
**D.** 28.7 cm
**E.** 30.5 cm

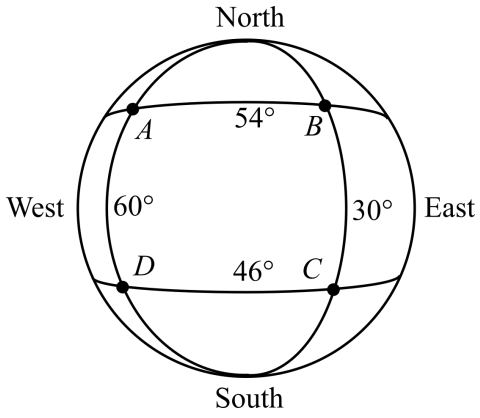
**Question 4**

The total surface area of the regular triangular pyramid, correct to one decimal place, is closest to

**A.** 94.9 $cm^2$
**B.** 219.0 $cm^2$
**C.** 314.0 $cm^2$
**D.** 657.1 $cm^2$
**E.** 752.0 $cm^2$

*Use the following information to answer Questions 5 and 6.*

Consider the four locations, *A*, *B*, *C* and *D*, on the surface of the Earth as shown on the diagram below.




**Question 5**

Which one of the following statements is **not** true?

**A.** The time difference between locations *A* and *B* is 2 hours.

**B.** Locations *B* and *C* are on the same meridian of 30°E.

**C.** The location of point *B* is latitude 54°N and longitude 30°E.

**D.** The angular distance between locations *A* and *D* is 100°.

**E.** Locations *C* and *D* are on the same parallel of 46°E.

**Question 6**

Assuming that the radius of Earth is 6400 km, the direct distance between locations *A* and *D*, measured along the 60°W meridian, is closest to

**A.** 6031 km

**B.** 6702 km

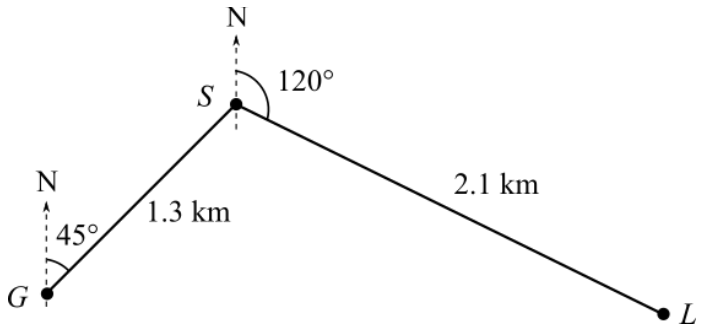
**C.** 10053 km

**D.** 11170 km

**E.** 12287 km

**Question 7**

Grace travels from her house, $G$, to school, $S$, 1.3 km on a bearing of 045°. After school she goes to study at the library, $L$, which is 2.1 km from the school on a bearing of 120° as shown in the diagram below.

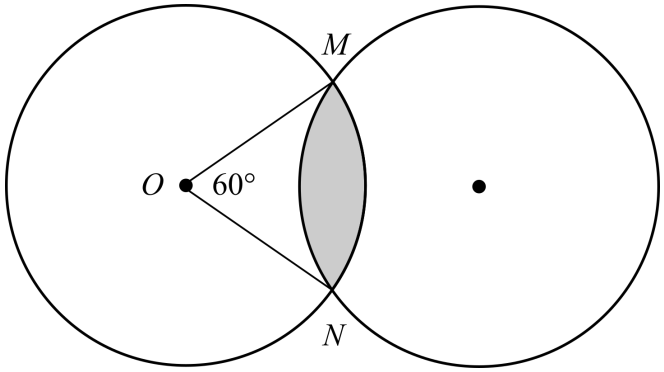



The direct distance from the library to Grace's house is closest to

**A.** 2.16 km
**B.** 2.61 km
**C.** 2.74 km
**D.** 2.86 km
**E.** 3.37 km

**Question 8**

Two circles of equal radii of 95 cm overlap forming the shaded region as shown on the diagram below.
$M$ and $N$ are the two points of intersection between the two circles.




If the angle at the centre, $\angle MON$, is 60°, then the area of the shaded region can be calculated using the formula

**A.** $\text{Area} = 9025\left(\frac{\pi}{6} - \frac{\sin(60°)}{2}\right)$

**B.** $\text{Area} = 9025\left(\frac{\pi}{3} - \sin(60°)\right)$

**C.** $\text{Area} = 9025\left(\frac{\pi}{3} + \sin(60°)\right)$

**D.** $\text{Area} = 9025\left(\frac{\pi}{3} - \cos(60°)\right)$

**E.** $\text{Area} = 9025\left(\frac{\pi}{6} + \cos(60°)\right)$

**END OF MODULE 3**
**SECTION B** – continued

# 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**

Consider the five linear equations given below.

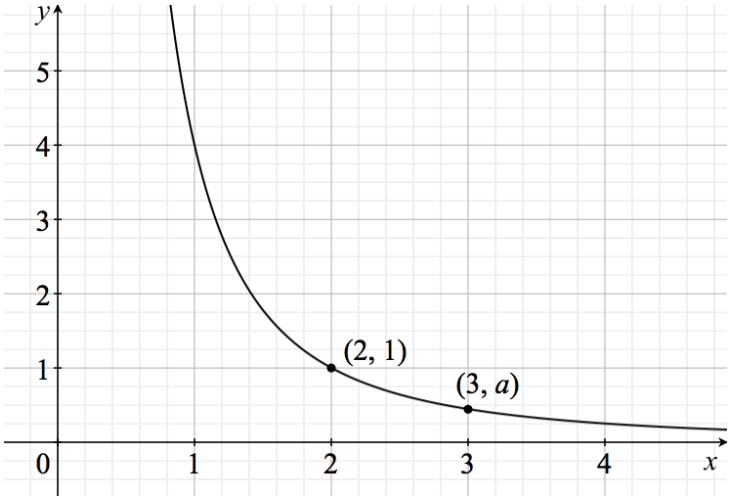
$$2x + 3y - 7 = 0 \qquad -7.8x + 1.2y - 3.9 = 0 \qquad -8x - 4y + 1 = 0 \qquad 9x - y + 2 = 0 \qquad \frac{1}{2}x - 6y - \frac{3}{4} = 0$$

How many of the linear equations above have a positive gradient and a negative $y$–intercept?

**A.** 1
**B.** 2
**C.** 3
**D.** 4
**E.** 5

**Question 2**

The points with coordinates (2, 1) and (3, $a$) lie on the graph of $y = kx^{-2}$ as shown on the graph below.




The values of $k$ and $a$ are respectively

**A.** 2 and $\frac{2}{3}$

**B.** $\frac{1}{2}$ and $\frac{1}{18}$

**C.** 4 and $\frac{4}{9}$

**D.** $\frac{1}{4}$ and $\frac{9}{4}$

**E.** 2 and $\frac{2}{9}$

**Question 3**

Brianna has a moneybox where she puts 20-cent coins and 50-cent coins. There are 60 coins in her moneybox with a total value of $19.50.

Let $f$ be the number of 50-cent coins.

Let $t$ be the number of 20-cent coins.

The values of $f$ and $t$ are

**A.** $f = 35$ coins and $t = 25$ coins

**B.** $f = 32$ coins and $t = 28$ coins

**C.** $f = 45$ coins and $t = 15$ coins

**D.** $f = 24$ coins and $t = 36$ coins

**E.** $f = 25$ coins and $t = 35$ coins

**Question 4**

A company manufactures schoolbags at a fixed cost of $1000 and a variable cost of $4.50 per schoolbag. The revenue function for this product is $R(x) = 0.02x^2 + 10x$, where $x$ is the number of schoolbags manufactured.

$C(x)$ represents the cost function for manufacturing $x$ schoolbags.

Which one of the following statements is **not** true for this situation?

**A.** The cost function is $C(x) = 1000 - 4.50x$.

**B.** The profit function is $P(x) = 0.02x^2 + 5.50x - 1000$.

**C.** The brake-even number of schoolbags manufactured is 125.

**D.** If only 100 schoolbags are manufactured the company incurs a loss.

**E.** The company makes a profit of $900 when 200 schoolbags are manufactured.

*Use the following information to answer Questions 5 and 6.*

A linear programming problem is defined by the four inequalities below.

$$0 \le x < 5$$
$$y \ge 0$$
$$3x - \frac{1}{2}y + 1 > 0$$
$$y \le -5x + 35$$

The point with coordinates $(2, p)$ does **not** lie within the feasible region.

**Question 5**

The value of $p$ could be

**A.** 4

**B.** 8

**C.** 10

**D.** 12

**E.** 14

**Question 6**

The maximum value of the objective function $F = ax + 3y$ occurs at the point with coordinates (3, 20), where $a$ is a positive real number.

The value of $a$ must be

**A.** $a \in (0, 30)$

**B.** $a \in (0, 15)$

**C.** $a = 15$

**D.** $a = 30$

**E.** $a \in (15, 30)$

**Question 7**

A horse is ridden in a parade for 10 minutes. The horse starts by walking 120 m in 2 minutes, stops for 3 minutes, then turns around and trots another 200 m in 1.6 minutes.

The relationship between the distance travelled by the horse from the starting point, $d$, in metres, and time, $t$, in minutes is defined by a function $d(t)$.

Which one of the following functions best defines the motion of the horse during the parade?

**A.** $d(t) = \begin{cases} 60 & 0 \le t \le 2 \\ 60t & 2 < t \le 3 \\ -125t + 745 & 3 < t \le 4.6 \end{cases}$

**B.** $d(t) = \begin{cases} 60t & 0 \le t \le 2 \\ 120 & 2 < t \le 5 \\ -125t + 745 & 5 < t \le 6.6 \end{cases}$

**C.** $d(t) = \begin{cases} 60t & 0 \le t \le 2 \\ 120t & 2 < t \le 5 \\ -125t & 5 < t \le 6.6 \end{cases}$

**D.** $d(t) = \begin{cases} 60 & 0 \le t \le 2 \\ 60 & 2 < t \le 5 \\ -200t & 5 < t \le 6.6 \end{cases}$

**E.** $d(t) = \begin{cases} 60t & 0 \le t \le 2 \\ 120 & 2 < t \le 3 \\ -200t + 1120 & 3 < t \le 6.6 \end{cases}$

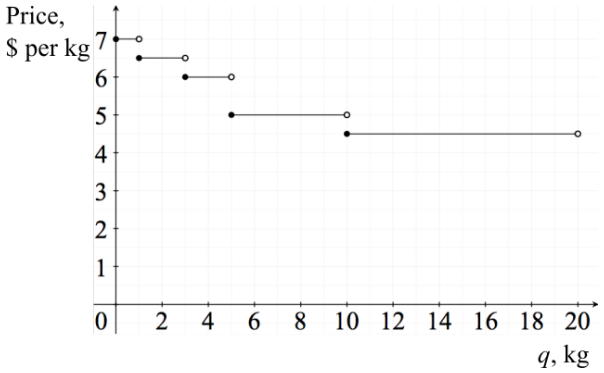
**Question 8**

A distributor sells dried fruit. The price per kilogram varies with respect to the quantity bought. The table below shows the sell price per kilogram.

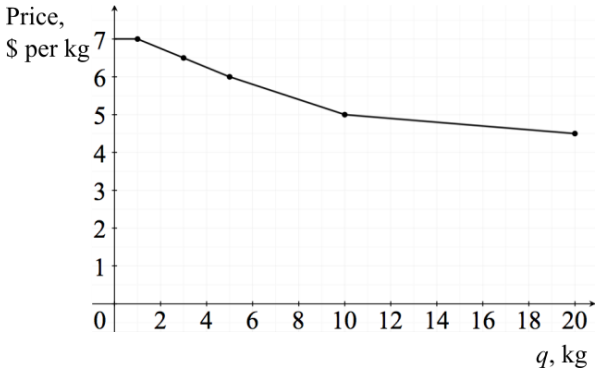
| Quantity, $q$, kg | Price per kilogram, $ |
|---|---|
| $0 < q \leq 1$ | 7.00 |
| $1 < q \leq 3$ | 6.50 |
| $3 < q \leq 5$ | 6.00 |
| $5 < q \leq 10$ | 5.00 |
| $10 < q \leq 20$ | 4.50 |

Which one of the following graphs displays this information?

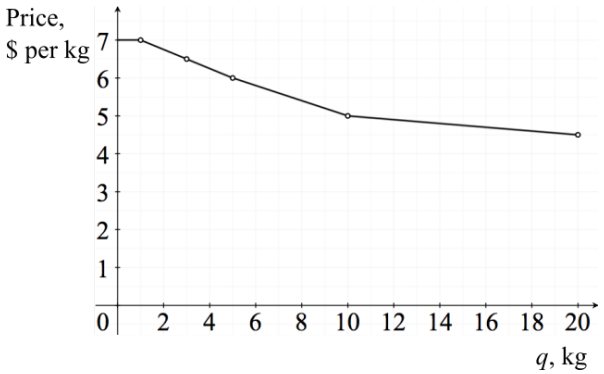
**A.**



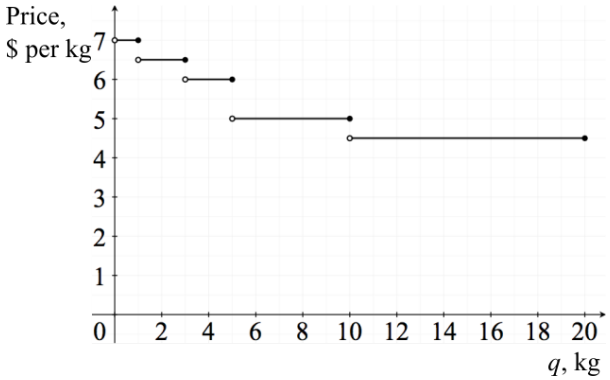

**B.**



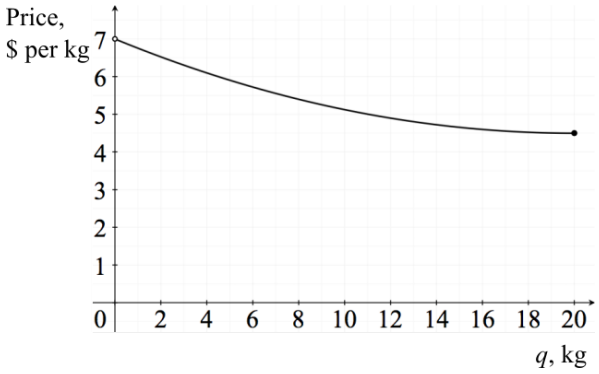

**C.**



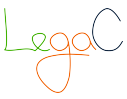

**D.**




**E.**




**END OF QUESTION AND ANSWER BOOK**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