2024 VCE General Mathematics 1 external assessment report

General comments

In 2024 students generally answered questions well in the General Mathematics Examination 1. There were challenges evident in some questions involving the application of the key skills and key knowledge from the study design. This was particularly the case in questions that required multiple steps or required multiple options being checked, such as:

- Questions 9 and 12 from Data analysis
- Questions 20, 23 and 24 from Recursion and financial modelling
- Questions 29, 31 and 32 from Matrices
- Questions 35, 37, 39 and 40 from Networks and decision mathematics.

Specific information

The examination comprised 40 multiple-choice questions covering all areas of study.

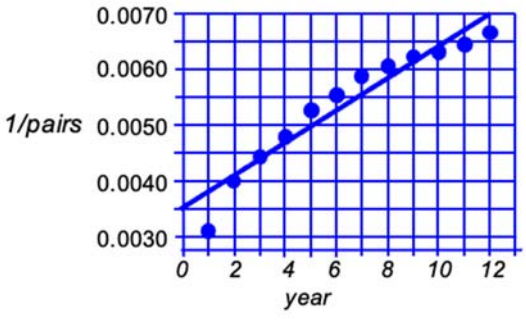
- Questions 1–16: Data analysis
- Questions 17–24: Recursion and financial modelling
- Questions 25–32: Matrices
- Questions 33–40: Networks and decision mathematics.

Students were permitted to use approved CAS technology in this examination.

The tables below indicate the percentage of students who chose each option. The correct answers are indicated by shading.

The statistics in this report may be subject to rounding, resulting in a total of more or less than 100 per cent.

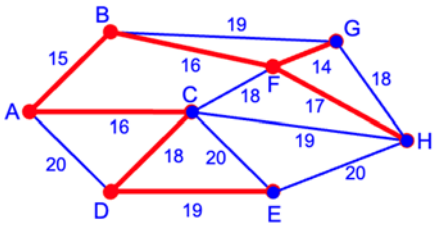
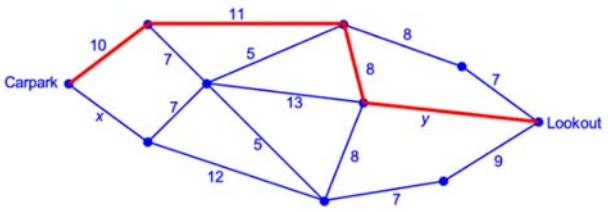
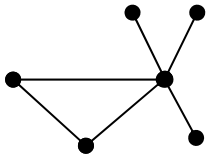
Question	Correct answer	% A	% B	% C	% D	% N/A	Comments
1	B	18	78	3	1	0	Blue 74 − 56 = 18
2	A	79	3	16	2	0	Both *payment preference* and a *budget preference are* categorical variables.
3	D	18	5	7	71	0	The median is the 14th value in a set of 27 values. Counting from the left the median occurs in the 5th column, which has a frequency of 9.

Question	Correct answer	% A	% B	% C	% D	% N/A	Comments
4	C	11	14	68	6	1	The outlier occurs between $\log_{10}$(population density) = 3.2 and $\log_{10}$(population density) = 3.4 2030 lies within this range as $\log_{10}(2030) = 3.307$
5	C	10	4	80	6	0	Calculate the five number summary. The median = 1.5
6	C	17	19	53	11	1	IQR = 48 − 5 = 43, Upper fence = 48 + 1.5 × 43 = 112.5 The smallest discrete value above 112.5 is 113
7	C	5	9	82	4	0	$s_x = \frac{x - \overline{x}}{z}$ $s_x = \frac{48 - 55.7}{-1.75}$ $s_x = 4.4$
8	B	17	73	5	4	0	Slope $= \frac{24 - 3}{30 - 7} \approx 0.91$ Using point (30,24) and $y = a + bx$, $a \approx -3.39$
9	A	52	13	13	20	1	$b = r \times \frac{s_y}{s_x}$, $r = b \times \frac{s_x}{s_y}$ $r = -1.27 \times \frac{8.51}{19.0} = -0.56882\ldots$
10	C	6	11	73	10	1	25.6 = 67.5 – 1.27 × *number* *number* = 32.992 ≈ 33
11	D	16	8	18	59	0	*pairs* $= 303 - 151 \times \log_{10}$ (*year*) to 3 significant figures
12	A	48	22	15	13	1	When the reciprocal transformation is applied and a regression line is fitted, it can be seen that the first point (year 1) is furthest from the regression line. 
13	A	72	13	7	8	0	The values of *new* in rank order are: 6, 6, 7, 10, 11, 12, 13. The median *new* value is 10.
14	B	15	68	12	5	1	The sum of new staff for 2011 to 2023 = 11 × 13 = 143 The sum of the previous 12 years = 127 The number of new staff in 2023 is 143 – 127 = 16

Question	Correct answer	% A	% B	% C	% D	% N/A	Comments
15	C	7	10	70	12	0	Six-mean smoothed value for months 2 to 7 = 318 Six-mean smoothed value for months 3 to 8 = 324 Six-mean smoothed value with centring for month 6 = $\frac{318+324}{2}=321$
16	C	19	16	58	7	1	Total seasonal indices for 12 months = 12 Seasonal index for month 3 + month 6 = 12 − (1.08 + 1.13 + 0.92 + 0.67 + 1.09 + 1.35 + 0.82 + 0.88 + 1.01 + 0.98) = 2.07 Month 3 $=2.07\times\frac{2}{3}=1.38$
17	D	14	25	24	36	1	For a geometric sequence, d always equals zero.
18	B	11	74	7	8	0	Interest rate = (1.00075 − 1) × 52 × 100 = 3.9%
19	C	4	13	72	11	0	Depreciation of 18% per annum equals (100 − 18)% = 82% = 0.82
20	B	23	48	18	10	1	Step 1. Calculate the interest for the compounding investment. Total value investment $=2000\left(1+\frac{4.4}{400}\right)^{3\times4}=2280.5723\approx2280.57$ Interest earned = 2280.57 − 2000 = 280.57 Step 2. Calculate the simple interest rate. $I=\frac{PRT}{100}$, $R=\frac{I\times100}{PT}$ $R=\frac{280.57\times100}{2000\times3}=4.67616\ldots\approx4.68$
21	D	12	15	16	56	1	Total repaid = 2228.40 × 5 × 12 = 133 704 Interest paid = Amount repaid − amount borrowed = 133 704 − 121 000 = 12 704
22	C	9	16	70	5	0	Interest rate = $\frac{960}{240000}=0.004$ Interest amount payment 2 = 238 218.95 × 0.004 = 952.8758 ≈ 952.88 Principal reduction = payment − interest = 2741.05 − 952.88 = 1788.17
23	A	54	13	18	14	1	Step 1. Monthly Interest rate $=\frac{960}{240000}=0.004$ Step 2. Annual interest rate = 0.004 × 12 × 100 = 4.8% Step 3. Use Finance Solver to find the time required to repay loan. I% = 4.8, PV = 240 000, Pmt = – 2741.05, FV = 0, PpY = CpY = 12

Question	Correct answer	% A	% B	% C	% D	% N/A	Comments
							Solve for N = 107.99992 ≈ 108 months ≈ 9 years
24	A	46	15	20	17	2	Step 1. Interest rate = (1.002 – 1) × 12 × 100 = 2.4% Step 2. Use Finance Solver to find the balance after two years. N = 2 × 12, I% = 2.4, PV = −18 000, Pmt = –100.00, PpY = CpY = 12 Solve for FV = 21 340.18471… ≈ 21 340.18 Step 3. Use Finance Solver to find payments for next three years. N = 36, I% = 2.4, PV = 21 340.18, FV = −30 000.00, PpY = CpY = 12 Solving for Pmt = 189.55465… ≈ 189.55
25	B	9	79	5	7	0	Order of product matrix *BC* is 2 × 1 For addition to occur, matrix *A* must also be 2 × 1
26	B	20	76	2	2	0	A discount of 15% per annum is equal to multiplying by (100 − 15)% = 85% = 0.85
27	B	17	50	17	15	1	The inverse does not to exist if the determinant = 0. Equate the determinant to zero and solve for *g*. $4 \times h - 8 \times g = 0$, $8g = 4h$, $g = \frac{h}{2}$
28	C	3	2	84	11	0	$W \times \begin{bmatrix} 1 \\ 1 \\ 1 \\ 1 \end{bmatrix} = \begin{bmatrix} 280 \\ 280 \\ 280 \end{bmatrix} \begin{matrix} F \\ N \\ T \end{matrix}$ 280 students compete in tennis
29	C	9	14	49	29	0	To solve this question students needed to complete either four separate calculations: For n weeks after week 1, the playing order is determined by $G_{n+1} = G_n \times P$ Week 1: G_1 given, $G_1 = [Q\ R\ S\ T\ U]$ Week 2: $G_2 = G_1 \times P = [S\ Q\ T\ U\ R]$ Week 3: $G_3 = G_2 \times P = [T\ S\ U\ R\ Q]$ Week 4: $G_4 = G_3 \times P = [U\ T\ R\ Q\ S]$ OR Students needed to complete one calculation: Week 4: $G_4 = G_1 \times P^3$, $G_4 = [U\ T\ R\ Q\ S]$
30	B	5	78	7	10	0	The Leslie matrix contains the birth rate for each age group in the first row. The survival rate for each age group will be shown in the next rows. The survival rate is from one age group to the next age group.

Question	Correct answer	% A	% B	% C	% D	% N/A	Comments
31	D	17	12	18	53	1	From inspection of the matrix, the two games to be played are between player I and players J and L. • There are four possible outcomes – player I wins both games, player I loses both games, player I beats player J but loses to player K, or player I loses to player J but defeats player K. • If player I wins both games, they will be the only player with three wins, two of them against the two players with two wins. Player I would be ranked first. Player K would be ranked fifth. • If player I loses both games, they will have only one win against a player with also just one win (player K), but K beat a player with three wins. Player I would be ranked fifth. • If player I loses to player J but beats player L, player J will have three wins and five two-steps, compared to player L with two wins and five two-steps. Player J would be ranked first. • If player I beats player J but loses to player L, four players will have two wins and player K will only have one, ranking fifth. Player J cannot rank fifth.
32	D	24	19	21	33	3	Given Thursday is S_0, Sunday is S_3 $S_3 = TS_2 + A$, hence $S_2 = T^{-1}(S_3 - A)$ $S_2 = TS_1 + A$, hence $S_1 = T^{-1}(S_2 - A)$ $S_1 = TS_0 + A$, hence $S_0 = T^{-1}(S_1 - A)$ $S_2 = \begin{bmatrix} 0.4 & 0.2 & 0.4 & 0 \\ 0.4 & 0.1 & 0.3 & 0.3 \\ 0.1 & 0.4 & 0.1 & 0.2 \\ 0.1 & 0.3 & 0.2 & 0.5 \end{bmatrix}^{-1} \left(\begin{bmatrix} 5620 \\ 6386 \\ 4892 \\ 6902 \end{bmatrix} - \begin{bmatrix} 300 \\ 200 \\ 100 \\ 300 \end{bmatrix} \right) = \begin{bmatrix} 5496 \\ 6168 \\ 4720 \\ 6516 \end{bmatrix}$ $S_1 = \begin{bmatrix} 0.4 & 0.2 & 0.4 & 0 \\ 0.4 & 0.1 & 0.3 & 0.3 \\ 0.1 & 0.4 & 0.1 & 0.2 \\ 0.1 & 0.3 & 0.2 & 0.5 \end{bmatrix}^{-1} \left(\begin{bmatrix} 5496 \\ 6168 \\ 4720 \\ 6516 \end{bmatrix} - \begin{bmatrix} 300 \\ 200 \\ 100 \\ 300 \end{bmatrix} \right) = \begin{bmatrix} 5832 \\ 6076 \\ 4120 \\ 5972 \end{bmatrix}$ $S_0 = \begin{bmatrix} 0.4 & 0.2 & 0.4 & 0 \\ 0.4 & 0.1 & 0.3 & 0.3 \\ 0.1 & 0.4 & 0.1 & 0.2 \\ 0.1 & 0.3 & 0.2 & 0.5 \end{bmatrix}^{-1} \left(\begin{bmatrix} 5832 \\ 6076 \\ 4120 \\ 5972 \end{bmatrix} - \begin{bmatrix} 300 \\ 200 \\ 100 \\ 300 \end{bmatrix} \right) = \begin{bmatrix} 4924 \\ 4732 \\ 6540 \\ 4904 \end{bmatrix}$ Botanical Gardens has 5620 viewers on Sunday and had 4924 viewers on Thursday. Number of viewers has increased by 5620 – 4924 = 696 viewers.

Question	Correct answer	% A	% B	% C	% D	% N/A	Comments
33	C	6	17	75	2	0	Summing the degrees at each vertex gives 1 + 3 + 4 + 2 + 2 = 12
34	C	7	4	85	3	0	A Eulerian trail must start and end at a vertex with an odd degree and pass along every edge only once.
35	B	14	52	9	25	0	The graph can be redrawn as planar. The number of faces can be counted or calculated using Euler's formula 7 + *f* = 11 + 2, gives *f* = 6.
36	D	4	9	4	83	0	Start with AB and connect to others by shortest distance available. Shown in red below. 
37	D	20	22	16	40	2	Shortest distance is marked in red on diagram below. 
38	A	18	32	33	17	1	The most efficient way to solve this question to draw some examples of possible graphs. One such graph is:  Check this diagram against each statement. This diagram has four vertices of odd degree. NO This diagram does NOT contain a Euler trail. NO This diagram does NOT contain a Hamiltonian path. NO The sum of the degrees of the vertices is 12. YES

<table>
<tr><th>Question</th><th>Correct answer</th><th>% A</th><th>% B</th><th>% C</th><th>% D</th><th>% N/A</th><th>Comments</th></tr>
<tr><td>39</td><td>D</td><td>11</td><td>45</td><td>23</td><td>19</td><td>1</td><td>
Step 1. Determine the initial allocation.
This can be done using the Hungarian algorithm or by inspection.
The initial task allocation to minimise the amount of time is:
<table>
<tr><td></td><td>Task 1</td><td>Task 2</td><td>Task 3</td><td>Task 4</td></tr>
<tr><td>Anush</td><td>12</td><td>8</td><td>16</td><td>9</td></tr>
<tr><td>Blake</td><td>10</td><td>7</td><td>15</td><td>10</td></tr>
<tr><td>Carly</td><td>11</td><td>10</td><td>18</td><td>12</td></tr>
<tr><td>Dexter</td><td>10</td><td>14</td><td>16</td><td>11</td></tr>
</table>
Anush (4), Blake (2), Carly (1) and Dexter (3)
Total time = 9 + 7 + 11 + 16 = 43 hours.
Step 2. Include Edgar and develop new allocation.
<table>
<tr><td></td><td>Task 1</td><td>Task 2</td><td>Task 3</td><td>Task 4</td></tr>
<tr><td>Anush</td><td>12</td><td>8</td><td>16</td><td>9</td></tr>
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<tr><td>Dexter</td><td>10</td><td>14</td><td>16</td><td>11</td></tr>
<tr><td>Edgar</td><td>9</td><td>5</td><td>14</td><td>8</td></tr>
</table>
If we work across the row for Edgar, Edgar could replace Carly on Task 1. This would save 2 hours and would not trigger a new allocation of tasks for the remaining workers since Carly takes longer on Tasks 2, 3 and 4 than other workers.
Edgar could replace Blake on Task 2. This would save 2 hours. Blake is free to take Task 3, this will save 1 hour. Dexter is free to take Task 1, this will save 1 hour.
New task allocation (including Edgar): Anush (4) unchanged, Edgar (2), Blake (3), Dexter (1).
Total time = 9 + 5 + 15 + 10 = 39 hours
Time saved = 43 – 39 = 4 hours
</td></tr>
<tr><td>40</td><td>B</td><td>35</td><td>32</td><td>19</td><td>13</td><td>1</td><td>
Inspection of the graph shows two activities that require four immediate predecessors.
Checking each option in turn:
Option A has one of these activities as G and the other as N. The table does not allow for the three-step path to G. Incorrect.
Option B has one of these activities as F and the other as K. Correct.
</td></tr>
</table>

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							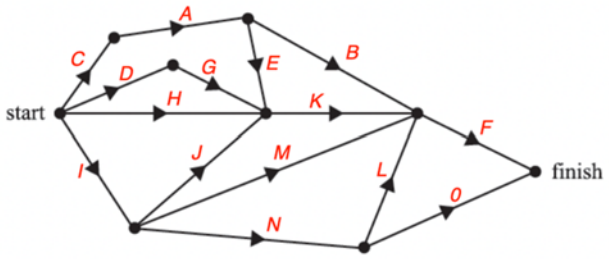 Option C has one of these activities as F and the other as K. Activity K requires both G and D; however, D is an immediate predecessor of G. Not possible. Option D has one of these activities as F and the other as K. Referring to the graph, it is not possible to have the same activity as an immediate processor to both F and K that is J. Incorrect.