2017 VCE Further Mathematics 2 examination report

General comments

Students were required to complete:

- a compulsory Core section of Data Analysis (worth 24 marks)
- a compulsory Core section of Recursion and financial modelling (worth 12 marks)
- two selected modules (worth 12 marks each).

The selection of modules by students in 2017 is shown in the table below.

Module	% 2017
Matrices	89
Networks and decision mathematics	51
Geometry and measurement	29
Graphs and relations	32

Throughout each section, questions progressively became more challenging.

Scanned images are used for assessing and students should ensure their answers can be clearly read. Students were asked to write in blue or black pen. Students are urged to take greater care with the presentation of their responses.

Students are expected to be familiar with the formula sheet, which is published on the VCAA website.

The importance of the 15-minute reading time cannot be overstated as it was clear that many students did not read the questions carefully and often gave an answer that did not relate to the question asked. Students are strongly encouraged to read the question again after they have completed their answer to ensure that they are answering appropriately. This can also assist with checking the reasonableness of the answer. For example, in Question 6c., the interest charged to Lily was often given as a value greater than the original bill. Re-reading the question would have alerted students to the fact that their answer was the total amount owing and not just the interest as required.

Many questions on the examination were worth one mark only, and with these questions the mark was awarded for a correct answer. Generally there was no need to put the answer into a sentence. Many students copied a correct answer incorrectly from calculations into a concluding sentence.

Some questions required the further application of a previous answer. If the previous answer had been incorrect, the student may have been eligible for consequential error consideration. For this to apply, working out needed to show a correct substitution of the previous reasonable, but

incorrect, answer into a relevant calculation. The resulting answer then needed to match that substitution and must also be a reasonable answer.

For questions worth more than one mark, students are strongly advised to show working. An incorrect answer will not be awarded any marks in a two-mark question; however, often a method mark can be awarded for an intelligible attempt. A suitable calculation or a table of input values for the finance solver are examples by which that understanding may be shown.

When descriptive answers are required to a question, brevity is encouraged in the response. Some students correctly answered a question and then added extra irrelevant information. However, this extra information cannot be awarded extra marks and, if it is incorrect, can lead to marks not being awarded.

Some questions on the examination asked students to 'show that' a particular answer could be obtained. Students must work towards the given result with all relevant steps shown. The answer the student is asked to show may be in a subsequent part of the question.

Rounding of answers to a specified level of accuracy is an important skill that students must be able to demonstrate. When completing the equation of a least squares line, some students did not understand the difference between decimal places rounding and significant figures rounding. In Recursion and financial modelling students are often asked to round their answer to the nearest cent. It is not appropriate to round to the nearest five cents or 10 cents in this instance.

Students should also take care to avoid premature rounding. They should use all the decimal places in their calculator for intermediate steps and then only round the final answer to the required accuracy level.

In questions where no instruction to round is given, an exact answer is required as rounding does not apply.

Specific information

This report provides sample answers or an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

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

Core – Data analysis

Question 1ai.

Marks	0	1	Average
%	13	87	0.9

72

This question was generally answered well. A small number of students wrote the answer as an interval, which was not accepted.

Question 1aii.

Marks	0	1	Average
%	13	87	0.9

25%

This question was generally well answered.

Question 1bi.

Marks	0	1	Average
%	31	69	**0.7**

84%

This question was reasonably well answered.

Question 1bii.

Marks	0	1	Average
%	53	47	**0.5**

975

Many students overlooked the requirement to convert from percentage to quantity and gave an answer of 97.5%.

Question 1c.

Marks	0	1	Average
%	33	67	**0.7**

105

This question was answered reasonably well.

Question 2a.

Marks	0	1	Average
%	8	92	**0.9**

Place of capture

This question was answered quite well, although a number of students gave a response that was not one of the two alternatives listed.

Question 2b.

Marks	0	1	Average
%	13	87	**0.9**

20 mm

Students answered this question well.

Question 2c.

Marks	0	1	2	Average
%	2	23	75	**1.8**

16 and 36

Overall, this question was answered well. The minimum of 16 was almost always given correctly. The Q_3 value was sometimes given incorrectly as 35.

Question 2d.

Marks	0	1	2	Average
%	20	15	65	**1.5**

Upper fence = 32 + 1.5 × 12 = 50

52 > 50, therefore outlier

The calculation of the upper fence of 50 was generally completed well.

A concluding statement that clearly showed that the student understood why 52 was an outlier given that the upper fence was 50 was required.

Question 2e.

Marks	0	1	2	Average
%	42	15	43	**1**

Forest 21

Grassland 30

Medians differ from forest to grassland.

Full marks were awarded to students who described a change in the median values and quoted these medians for both places of capture.

The mean is not part of a stemplot five-number summary and was not appropriate to use because of the outlier of 52 in the forest data.

Students who initially gave the required median comparisons and then went further by quoting comparisons of other irrelevant statistics were not awarded full marks.

Question 3a.

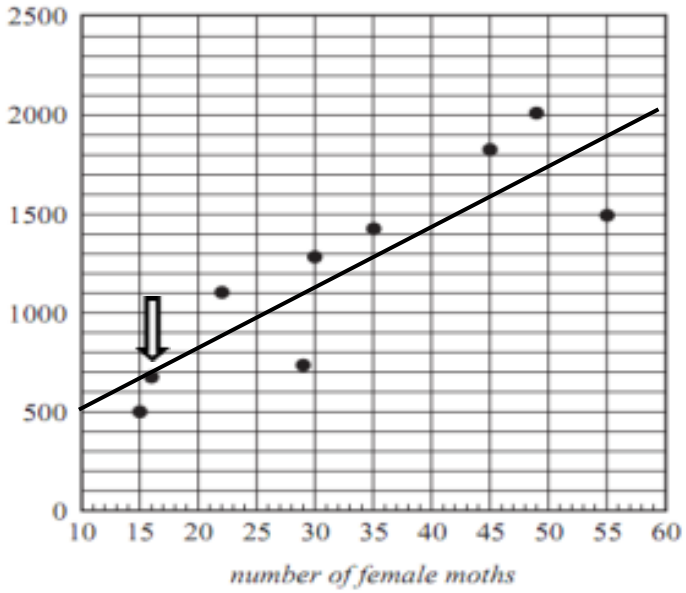
Marks	0	1	2	Average
%	20	13	67	**1.5**

egg density = [–46.8] + [18.9] × *number of male moths*

This question was generally answered quite well, although rounding to one decimal place was a problem for some students. The first number was sometimes written as –46.9.

Question 3bi.

Marks	0	1	Average
%	74	26	0.3



This question was not answered well. Many students did not realise that the scale on the horizontal axis started at 10 and not 0. It was clear that some students did not take a ruler into the examination.

Question 3bii.

Marks	0	1	Average
%	61	39	0.4

On average, *egg density* increases by 31.3 eggs/m^2 for each additional female moth caught.

Students were not awarded marks when their response did not clearly refer to the increase in egg density for every one-unit increase in female moths.

Interpretation of the slope needed reference to a ratio of changes – a change in response variable compared to a change in explanatory variable. Both variables needed to show change. Some acceptable answers were:

- *egg density* increases by 31.3 as the *number of female moths* increases by 1
- *egg density* increases by 31.3 for an increase of 1 in the *number of female moths* caught
- *egg density* increases by 31.3 for each additional *female moth* caught.

The following examples missed the key element that both variables have a quantifiable change:

- *egg density* increases by 31.3 for each *female moth*
- *egg density* increases by 31.3 for each increase in the *number of female moths* caught.

The latter suggests that the same egg density increase applies to any increase in the number of female moths, be it 1, 2, 5 or 10.

Question 3biii.

Marks	0	1	Average
%	52	48	**0.5**

–412.5

The most common incorrect calculation led to a positive residual of 412.5.

Rounding did not apply to this question, so –412.5 was the only acceptable answer.

Question 3biv.

Marks	0	1	Average
%	53	47	**0.5**

74.3%

Some students rounded to 0.7 first and then converted to 70%. Quite a few students gave 86.2%.

Question 4a.

Marks	0	1	Average
%	56	44	**0.8**

0.00854

Common incorrect responses were 0.009 and 0.00853.

Question 4b.

Marks	0	1	2	Average
%	50	13	37	**0.9**

$\log_{10}(\textit{area}) =$ [–14.4] + [0.00854] × *year*

Some students did not recognise that the rounded slope value from part a. was a required value in part b.

Some students appeared to have renumbered the values of the variable *year* as 1, 2, 3, etc. This was not asked for and was inappropriate given the increments of 10 in the given values.

Question 4ci.

Marks	0	1	Average
%	71	29	**0.3**

708 hectares

This question was not answered well. 709 was a common incorrect response.

Question 4cii.

Marks	0	1	Average
%	47	53	**0.6**

Extrapolating beyond the data range

Many students recognised that extrapolation leads to limited reliability of predictions.

Core – Recursion and financial modelling

Question 5a.

Marks	0	1	2	Average
%	2	3	95	**2**

$V_0 =$ 75 000

$V_1 =$ 75 000 – 3375 = 71 625

$V_2 =$ 71 625 – 3375 = 68 250

This question was answered well. A few students made careless transcription errors.

Question 5bi.

Marks	0	1	Average
%	4	96	**1**

$3375

This question was answered well.

Question 5bii.

Marks	0	1	Average
%	31	69	**0.7**

4.5%

This question was answered reasonably well.

Question 5c.

Marks	0	1	Average
%	42	58	**0.6**

5.7%

This question was answered reasonably well. Some students gave 9.43% or 94.3% as their answer.

Question 6a.

Marks	0	1	Average
%	39	61	**0.6**

$203

Many students did not read that the given interest rate was per month, so $200.25 was a common incorrect answer.

Question 6b.

Marks	0	1	2	Average
%	46	15	39	**1**

$A_0 = 428$ $A_{n+1} = 1.015\,A_n$

Many students did not write a recurrence relation in the required form.

A recurrence relation has the initial value written first.

The name of the variable needed to be consistent in the recurrence relation.

Some students did not recognise the difference between the recurrence relation above and the rule $A_n = 428 \times 1.015^n$.

Question 6c.

Marks	0	1	Average
%	74	26	**0.3**

$26.26

Some students who answered parts a. and b. correctly gave $454.26 as the answer here, which was the total amount Lily was charged rather than the interest. An answer to the nearest (one) cent was required, not the nearest five or 10 cents.

Question 7a.

Marks	0	1	Average
%	50	50	**0.5**

$1 560

Some students gave the annual payment of $18 720, while others knew the correct method but rounded $\frac{5.2}{1000}$ to two decimal places before multiplying by $360 000, giving $1 548.

Question 7b.

Marks	0	1	2	Average
%	69	5	26	**0.6**

$805.65

Formulas should not have been used. The finance solver entries required were:

N = 48

I% = 3.8

PV = –360 000

PMT = –500

FV = 444 872.9445

P/Y = C/Y = 12

∴ Balance after 4 years = $444 872.9445

N = 24

I% = 3.8

PV = –444 872.9445

PMT = –805.6505059

FV = 500000

P/Y = C/Y = 12

Some students entered the $500 payment as a positive into their finance solver, giving $393 121.15 as the four-year value.

A few students tried to use a formula but made little progress.

Module 1 – Matrices

Question 1a.

Marks	0	1	Average
%	11	89	**0.9**

159

This question was answered well, although a few students gave 56 as their answer, which was the number sold in week 3.

Question 1b.

Marks	0	1	Average
%	25	75	**0.8**

The number of rolls sold in week 1, which was 24.

This question was answered quite well. Some students simply gave the element 24.

Question 1ci.

Marks	0	1	Average
%	44	56	**0.6**

$3.80

Many students were unable to solve the matrix equation. Even those who did so correctly usually showed no working.

Question 1cii.

Marks	0	1	Average
%	72	28	**0.3**

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

Some were correct but many students gave a 3 × 1 matrix.

Question 2a.

Marks	0	1	Average
%	5	95	**1**

40%

This question was answered very well.

Question 2b.

Marks	0	1	Average
%	31	69	**0.7**

300 × [0.4] + 240 × [0.6] + 210 × [0.2] = 306

This question was answered quite well. Some students gave the answers as percentages. A few just gave 40, 60, 20.

Question 2c.

Marks	0	1	Average
%	70	30	**0.3**

750

This question did not require any working if students realised that the original population of 750 remained unchanged throughout the transition process.

Those who calculated the figures for Term 4 often ended up with a total of 749 due to rounding or did not give the final answer as a total.

Question 3a.

Marks	0	1	Average
%	53	47	**0.5**

0.4 × 300 + 0.4 × 200 + 0.3 × 200 + 0.2 × 300 = 320

Question 3b.

Marks	0	1	Average
%	27	73	**0.8**

$$\begin{bmatrix} 250 \\ 250 \\ 300 \\ 200 \end{bmatrix}$$

This question was answered quite well. Students who answered incorrectly tended to give the state matrix for Term 3.

Question 3c.

Marks	0	1	2	Average
%	86	1	12	**0.3**

25%

200 expected in service in Term 2

30% of 200 = 60 from service to investigation in Term 3

240 expected in investigation in Term 3

$$s_3 \begin{bmatrix} 260 \\ 240 \\ 295 \\ 205 \end{bmatrix} \begin{matrix} C \\ I \\ P \\ S \end{matrix} \text{ and } \frac{60}{240} = 25\%$$

This question was not answered well. Some students were able to find either the 240 doing investigation or the 60 transitioning from service to investigation but were unable to link these together.

Question 3d.

Marks	0	1	Average
%	57	43	**0.5**

250

239 was the most common incorrect response from the steady state matrix.

Module 2 – Networks and decision mathematics

Question 1a.

Marks	0	1	Average
%	6	94	**1**

$120

This question was answered very well.

Question 1b.

Marks	0	1	Average
%	21	79	**0.8**

Quigley and Rosebush

This question was generally answered well.

Some gave the path *N*-*Q*-*R*-*S*, which was accepted.

Question 1c.

Marks	0	1	Average
%	17	83	**0.9**

6	+	7	=	11	+	2
v		*f*		*e*		

This question was generally answered well, although some students did not seem to check that the values were arithmetically correct, for example, 6 + 6 = 11 + 2.

Question 2a.

Marks	0	1	Average
%	63	37	**0.4**

Colin must plan Tour 2.

This question was not well answered.

Students needed to state that Colin must plan Tour 2 (or equivalent).

Many gave additional information usually from values in Table 1; however, Table 1 did not need to be considered at all.

An answer such as ‘Colin will plan Tour 2 and take 8 minutes to do it’ was acceptable as the extra information was correct and did not negate the first part.

However, an answer such as ‘Colin will plan Tour 2 because he is the fastest’ was not correct as Diane could plan Tour 2 more quickly than Colin.

The algorithm gives the best overall allocation taking all values into account.

Question 2b.

Marks	0	1	Average
%	42	58	**0.6**

43 minutes

Some responses showed evidence of the correct allocation but did not give the total planning time.

Question 3ai.

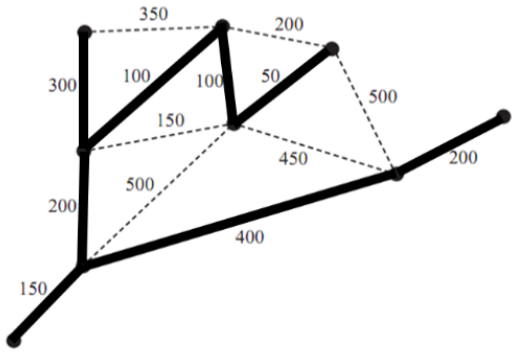
Marks	0	1	Average
%	37	63	**0.7**

Minimal spanning tree

This question was answered reasonably well. Some students gave ‘spanning tree’ only.

Question 3aii.

Marks	0	1	Average
%	47	53	**0.6**



This question was answered quite well, including by many students who were unable to name the graph in part ai.

Question 4a.

Marks	0	1	Average
%	33	67	**0.7**

D and *E*

This question was answered quite well. The dummy is not an activity and hence writing it as an additional predecessor could not be accepted.

Question 4bi.

Marks	0	1	Average
%	56	44	**0.5**

A–E–I–L–N

Quite a few students gave *A–D–I–L–N*.

Question 4bii.

Marks	0	1	Average
%	72	28	**0.3**

6 days

This question was not answered well, with 7 and 5 the most common incorrect responses.

Question 4ci.

Marks	0	1	Average
%	65	35	**0.4**

17 days

Reduce activities *I*, *J* and *L* on the critical path. The original critical path is now 17 days.

Creates a new critical path of *A*–*C*–*G*–*N*, taking 18 days.

Also reduce activity *G*.

Question 4cii.

Marks	0	1	Average
%	85	15	**0.2**

$4000

This question was not answered well. Some students recognised the need to reduce the critical activities (*I*, *J* and *L*) but did not realise that activity *G* also had to be reduced as it was part of a new critical path formed.

Module 3 – Geometry and measurement

Question 1ai.

Marks	0	1	Average
%	16	84	**0.9**

760 cm^2

This question was answered well.

Question 1aii.

Marks	0	1	Average
%	26	74	**0.8**

5296 cm^2

$2 \times (32 \times 40 + 32 \times 19 + 760) = 5296$

This question was answered reasonably well.

Question 1b.

Marks	0	1	Average
%	68	32	**0.3**

80 cm

$\sqrt[3]{8} \times 40 = 80$

This question was not answered well. Many students did not calculate the linear scale factor of 2 and gave an answer of 320 cm.

Question 2a.

Marks	0	1	Average
%	60	40	0.4

8.00 pm Wednesday

Melbourne time = 11.20 + 10.40 = 22.00

Tokyo time – subtract 2 hours

Some students added two hours rather than subtracting them.

Question 2bi.

Marks	0	1	Average
%	39	61	0.6

193 metres

This question was not always answered well.

Question 2bii.

Marks	0	1	Average
%	73	27	0.3

345°, calculated from $360^\circ - \tan^{-1}\left(\frac{50}{186}\right)$

This question was not answered well. Some students gave 015 degrees. N 15° W is not a three-figure bearing and was not accepted.

Question 2c.

Marks	0	1	Average
%	57	43	0.5

4681 km

$6400 \times \cos 43^\circ = 4681$

Question 2d.

Marks	0	1	Average
%	62	38	0.4

9048 km

$\frac{81}{360} \times 2\pi \times 6400 = 9048$

Question 3a.

Marks	0	1	Average
%	44	56	0.6

$65^2 = 50^2 + 50^2 - 2 \times 50 \times 50 \times \cos\theta$

or

$\cos\theta = \dfrac{50^2 + 50^2 - 65^2}{2 \times 50 \times 50}$

Most students were able to write the equation, but some made errors in the rule by placement of a 65 where a 50 should have been or vice versa.

Question 3b.

Marks	0	1	Average
%	66	34	0.4

438 metres

$3 \times 65 + \dfrac{(360 - 81)}{360} \times 2\pi \times 50 = 438$

Students who could apply the formula for arc length, generally answered this question well.

Question 3c.

Marks	0	1	2	Average
%	66	2	33	0.7

153 metres

$50 + 65 + \sqrt{50^2 - 32.5^2} = 153$

This question was not answered well. Some students made an incorrect assumption about the distance in the square/circle overlap.

Module 4 – Graphs and relations

Question 1a.

Marks	0	1	Average
%	9	91	0.9

2 metres

This question was answered well.

Question 1b.

Marks	0	1	Average
%	14	86	0.9

8.00 am – 6.00 pm

This question was answered well.

Question 2a.

Marks	0	1	Average
%	27	73	0.8

600 metres

This question was answered quite well, although 400 was a common incorrect response that ignored the scenario where Edgar had travelled 500 m out and then 100 m back.

Question 2b.

Marks	0	1	Average
%	51	49	0.5

$$k = \frac{500}{12.5}$$

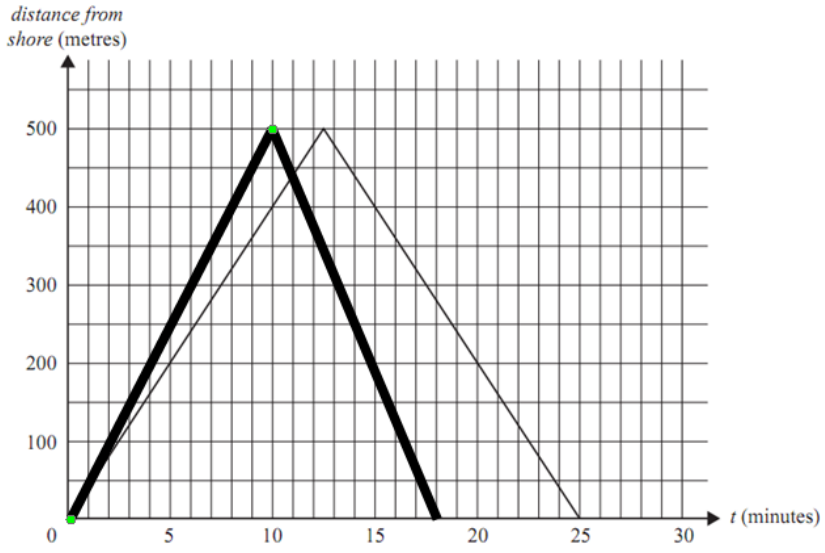
Students needed to show this division or an equivalent using two points on the first line.

It was not sufficient to substitute in values or to give the equation and write 'solve'.

A few students calculated an average speed for the entire swim, not just the outward leg as required.

Question 2c.

Marks	0	1	2	Average
%	44	16	39	1



Most students gave the first of the two line segments correctly but the second segment often ended at 20 or beyond.

Question 2d.

Marks	0	1	Average
%	73	27	**0.3**

10.98 minutes

This question was not answered well. The answer was obtained by solving $40t = -62.5t + 1125$ and rounding correct to two decimal places. A common incorrect answer (without working) was 11, likely due to rounding to the nearest minute or reading from the graph.

Question 3a.

Marks	0	1	Average
%	22	78	**0.8**

2

This question was answered well.

Question 3b.

Marks	0	1	Average
%	37	63	**0.7**

The total number of junior and senior lifeguards must be at least 12.

This question was answered well, although some students misinterpreted the inequality.

A common incorrect response was 'Total number of lifeguards must be more than 12'.

Question 3c.

Marks	0	1	2	Average
%	38	3	59	**1.2**

$220

Minimum cost at (8, 4)

$C = 15 \times 8 + 25 \times 4 = 220$

This question was answered reasonably well. Some students recognised the minimum point but made arithmetic errors when substituting into the cost equation.

Question 3d.

Marks	0	1	Average
%	76	24	**0.3**

Junior lifeguards | 9 | Senior lifeguards | 3 |

This question was not answered well, although most students recognised the need for integer solutions. 10 and 3 was a common incorrect response.