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AS/A LEVEL GCE

Examiners' report

MATHEMATICS (MEI)

3895-3898, 7895-7898

4772/01 Summer 2018 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates. The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report. A full copy of the question paper can be downloaded from OCR.

Paper 4772/01 series overview

Decision 2 (4772/01) can be taken as the second optional component in A Level Mathematics, or as one of the optional components in AS/A Level Further Mathematics. There is an emphasis on mathematical modelling and the best prepared candidates would be familiar the use of algorithms in a variety of situations, building upon the content of Decision 1 (4771/01).

This is the last full assessment series for the 3895-3898/7895-7898 Mathematics (MEI) specification. There will be a resit series in 2019. The Decision strand will not be available as part of the reformed AS/A Level Mathematics content, but some of this content will form part of the optional components available in the reformed AS/A Level Further Mathematics specifications.

As noted in the examiner's reports of previous years, the majority of candidates appeared well prepared for this examination and made a good attempt on each question. Whilst the calculations were performed extremely competently, candidates struggled more on the explanations, often providing responses that were overly long and convoluted (and sometimes contradicting), or not directly relevant to the context of the question. There was no evidence that candidates struggled to complete the paper in the available time.

This report should be used in conjunction with the published mark scheme.

Key

AfL Guidance to offer for future teaching and learning practice.

Misconception

Question 1 (i)

1 Sarah is considering planting vegetables to be harvested in three months' time. Seeds and other material will cost her £25. If the weather gives good growing conditions her vegetables will be worth £95. If not, her vegetables will be worth £75.
Alternatively, she can plant flowers, which will cost her £20. If the weather gives good growing conditions her flowers will be worth £85 in three months' time. If not they will be worth £75.
The long-range weather forecast gives a probability of 0.6 of good growing conditions, and a probability of 0.4 of growing conditions which are not good.

(i) Draw a decision tree for Sarah. **[3]**

Virtually all candidates were successful with this.

Question 1 (ii)

(ii) Give the best course of action and its EMV. **[6]**

Again, virtually all candidates could do this. There were very few errors.

Decision Analysis is powerful. It was good to see this success with it.

Question 1 (iii)

Sarah is a member of a horticultural society. The society offers an 'advice on growing' service for members, based on an analysis of the soil and other growing conditions. From past experience the society estimates that paying for and following its advice leads to a 20% increase in amounts grown for both vegetables and flowers under good growing conditions, and a 10% increase in amounts grown if growing conditions are not good.

(iii) Find the value of the society's advice. **[4]**

Most candidates had a good understanding of what was required here. There were two common errors:

Some candidates incorrectly increased the costs as well as the benefits, by 20% and 10% respectively.

Some candidates did not incorporate the decision of whether or not to pay for advice into an expanded tree. This was not strictly needed to answer the question, but is seen as good practice.

Question 1 (iv)

Sarah decides to split her planting equally between vegetables and flowers.

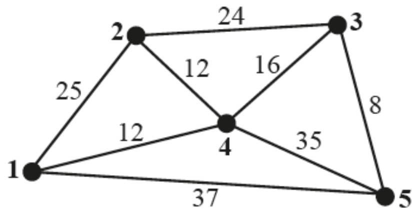
(iv) What is the value of the society's advice when she splits her planting equally between vegetables and flowers? **[3]**

This was a question which required candidates to apply their knowledge to the specific context of the scenario, whilst most candidates were able to gain at least one mark, less than 50% secured full marks.

A common error was to use the EMV of £62 from part (ii) as the baseline for this computation, rather than £(61+62)/2 = £61.50

Question 2 (i)

2 The five nodes in the network below represent electricity supply poles in a rural village. The arcs represent paths connecting the positions of those poles. The weights on the arcs are distances in metres.



The electricity supply company will need to:

1. know the shortest routes between poles
2. have an efficient (short) route to inspect each pole, starting and ending at pole **1**
3. know how to connect the poles with cables so that the length of cable is as short as possible
4. know the shortest distance to traverse all the paths so that they can be maintained efficiently.

(i) Completed distance and route matrices are shown at the end of the third and fifth iterations of Floyd's algorithm, along with incomplete fourth iteration matrices. Complete the matrices for the fourth iteration. **[5]**

Candidates had been well prepared for this, and there were few errors. It was particularly pleasing to see most producing the correct entry in row 5 column 1 of the route matrix.

Question 2 (ii)

	1	2	3	4	5
1	50	25	49	12	37
2	25	48	24	12	32
3	49	24	48	16	8
4	12	12	16	24	24
5	37	32	8	24	16

	1	2	3	4	5
1	2	2	2	4	5
2	1	3	3	4	3
3	2	2	2	4	5
4	1	2	3	1	3
5	1	3	3	3	3

	1	2	3	4	5
1				12	
2				12	
3				16	
4	12	12	16	24	24
5				24	

	1	2	3	4	5
1				4	
2				4	
3				4	
4	1	2	3	1	3
5				3	

	1	2	3	4	5
1	24	24	28	12	36
2	24	24	24	12	32
3	28	24	16	16	8
4	12	12	16	24	24
5	36	32	8	24	16

	1	2	3	4	5
1	4	4	4	4	4
2	4	4	3	4	3
3	4	2	5	4	5
4	1	2	3	1	3
5	3	3	3	3	3

(ii) Use the final matrices to find the shortest route and shortest distance from **1** to **5**, showing how you used the matrices. **[2]**

Many candidates found it difficult to "show how", although a majority managed a muddled explanation that was judged sufficient for full credit.

Good maths and good communication go together hand-in-glove. The maths would benefit from more attention on the communication - it is at least arguable that thinking is communicating with oneself.

Question 2 (iii)

(iii) By temporarily deleting pole **4** and its arcs, find a lower bound for the minimum distance Hamilton cycle in the complete network of shortest distances.
(You may find by inspection the minimum connector which you need.) **[3]**

The majority of candidates made a good attempt, although slips were not uncommon.

Question 2 (iv)

(iv) Use the nearest neighbour algorithm, starting at **1**, to find a Hamilton cycle in the complete network of shortest distances. Give the length of your cycle and the corresponding route through the original network. **[2]**

Again, most could do this, and most were aware of the relationship between the complete network of shortest distances and the original network.

Question 2 (v)

(v) Find the shortest distance to traverse every path in the network, given that the total length of the paths is 169 metres. **[2]**

This required the candidates to be algorithmic. A minority attempted to answer without using all three pairings of odd nodes.

Question 2 (vi)

(vi) Which of the electricity supply company's needs has not yet been addressed, and what is the answer to it? **[2]**

The original intention had been to ask candidates why the third requirement of the company could not be answered from the information provided – it requires the use of direct, straight-line distances (ignoring the catenary) in constructing the minimum connector. In the event candidates were credited the second mark either for recognising the need for the minimum connector, or for incorrectly constructing it using path lengths.

Question 3 (i)

3 An animal food retailer plans to place a bulk order for 100 m^3 of foods from his wholesaler. There are three types of food which he will mix to sell on to his customers, subject to constraints described below.

Food A costs £250 per m^3, contains 15% fibre, 3.5% fat, and 10% protein.

Food B costs £300 per m^3, contains 12% fibre, 4% fat, and 15% protein.

Food C costs £150 per m^3, contains 10% fibre, 2% fat, and 10% protein.

The mixed product must contain at least 13% fibre, at least 3% fat, and at least 13% protein.

The following LP is formulated to help the retailer to decide what order to place.

Min $250a + 300b + 150c$

st $a + b + c = 100$

$15a + 12b + 10c \geqslant 1300$

$3.5a + 4b + 2c \geqslant 300$

$10a + 15b + 10c \geqslant 1300$

(i) Explain the purpose of each part of this formulation. **[6]**

The need to identify variables explicitly has consistently been emphasised in feedback on OCR Decision Maths papers. The formulaic "Let *x* be the number of …" phrasing almost always appears. In this case, with a given formulation, candidates needed to note that *a* represented the number of cubic metres of food A, etc. Many candidates did not do that.

Question 3 (ii)

The initial tableau for an application of the two-phase simplex algorithm is

P	A	B	C	s1	s2	s3	s4	s5	a1	a2	a3	a4	rhs
1	29.5	32	23	0	−1	−1	−1	−1	0	0	0	0	3000
0	−250	−300	−150	0	0	0	0	0	0	0	0	0	0
0	1	1	1	1	0	0	0	0	0	0	0	0	100
0	1	1	1	0	−1	0	0	0	1	0	0	0	100
0	15	12	10	0	0	−1	0	0	0	1	0	0	1300
0	3.5	4	2	0	0	0	−1	0	0	0	1	0	300
0	10	15	10	0	0	0	0	−1	0	0	0	1	1300

The first pivot is to be chosen from the B column. The pivot element is shaded.

(ii) Explain why this is the pivot element. **[1]**

Echoing the comments from 2(ii), many candidates did not earn this explanation mark. In this case, the maths should have helped the communication – we were looking for 300/4 rather than looking for an essay.

Question 3 (iii)

(iii) Perform the first iteration and write down the resulting tableau. **[5]**

Again, candidates were very well prepared for this routine work. It was pleasing to note very high standards of numeracy.

Question 3 (iv)

(iv) Choose a pivot element for the second iteration. **[1]**

All could do this, with just a very few slips.

Question 3 (v)

After several more iterations the first entry in the 'rhs' column is reduced to 0. The tableau is then:

P	A	B	C	s1	s2	s3	s4	s5	a1	a2	a3	a4	rhs
1	0	0	0	−1	−1	0	0	0	0	−1	−1	−1	0
0	0	0	0	−270	0	−20	0	−22	0	20	0	22	27600
0	0	0	1	4.2	0	0.2	0	0.12	0	−0.2	0	−0.12	4
0	0	0	0	−1	−1	0	0	0	1	0	0	0	0
0	1	0	0	−1.2	0	−0.2	0	0.08	0	0.2	0	−0.08	36
0	0	1	0	−2	0	0	0	−0.2	0	0	0	0.2	60
0	0	0	0	−3.8	0	−0.3	1	−0.28	0	0.3	−1	0.28	74

(v) Give a full interpretation of this tableau. **[7]**

Very few candidates made the essential observation that the first zero in the RHS column shows that the solution represented by the tableau is a feasible solution. Equally very few noted that the solution is optimal.

On the other hand, it was expected that the "74" in the RHS column would be difficult to interpret, but in the event, many managed a full and accurate interpretation.

Question 4 (a)

4 **(a)** Identify which of the following deductions are correct. For those that are not correct, show why they are not.

(i) If it is raining, then you must put up your umbrella. It is raining.
Therefore you must put up your umbrella.

(ii) If it is raining, then you must put up your umbrella. You have put up your umbrella.
Therefore it is raining.

(iii) All cows have three legs. Ermintrude is a cow.
Therefore Ermintrude has three legs.

(iv) All cats purr. This animal purrs.
Therefore this animal is a cat.

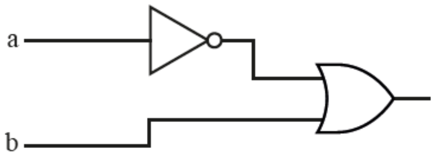
(v) If it is very windy we will not ski. It is not very windy.
Therefore we will ski. **[8]**

Almost all candidates were able correctly to identify which deduction was correct, and which incorrect. However, as might be expected given comments above, for the incorrect deductions "show why they are not" created difficulties.

Answers which did not score included those that simply rephrased the statement that the deduction was incorrect. For instance, for 4(a)(ii), "r⇒u and u does not imply r". Answers which invariably secured the mark included those in which good counter responses were offered, for instance in 4(a)(ii) "The umbrella might be in use as a sunshade".

Question 4 (b) (i)

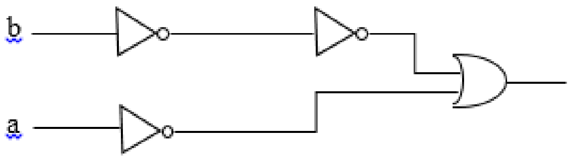
(b) The diagram shows a combinatorial circuit for $a \Rightarrow b$.



(i) Draw a combinatorial circuit for $\sim b \Rightarrow \sim a$. **[2]**

Part (b) was in three parts, each about the logical equivalence of implication and the contra-positive.

Candidates knew about this equivalence but allowed that knowledge to throw them completely in part (b)(i). Almost all candidates, having been shown a combinatorial circuit for $a \Rightarrow b$, drew that circuit in answer to the request for a combinatorial circuit for $\sim b \Rightarrow \sim a$. The correct answer, shown below, provides a template for the symbolic manipulation required in part (b)(iii).



Question 4 (b) (ii)

(ii) Use a truth table to prove that $(a \Rightarrow b) \Leftrightarrow (\sim b \Rightarrow \sim a)$. **[3]**

All could do this, with very few slips.

Question 4 (b) (iii)

(iii) Use Boolean algebra to prove that $(a \Rightarrow b) \Leftrightarrow (\sim b \Rightarrow \sim a)$. **[3]**

Most candidates knew the three parts that needed to be put together to produce a proof, but only about 50% of them could complete that articulation.

Many of those who did not, made the classic error of assuming what they wished to prove, and then deducing truth, as in $1=(-1) \Rightarrow (1)^2=(-1)^2 \Rightarrow 1=1$.

Question 4 (c)

(c) When there is an electrical storm Keith's garage door mechanism can be damaged. When the garage door mechanism is damaged the residual current circuit breaker (the RCCB) can trip immediately, or when the mechanism is activated.

When the RCCB trips, it turns off all of the electricity supply to the house.

When water penetrates the outside light control, the RCCB can trip when the light is turned on.

Both the garage door mechanism and the outside light control can be switched off independently. The RCCB can be re-set, although it will trip again immediately if there is still a problem with a component connected to the power supply.

Keith returns home after a wet and stormy day to find that the outside light will not turn on and the garage door will not open. He finds that the RCCB has tripped.

What should he do? Describe what actions he should take to determine why the RCCB tripped, and what he will be able to deduce. **[4]**

This question proved challenging with very few fully correct responses. Few candidates made a thorough attempt to answer the question in terms of the actions which were defined in the question. Instead, hopeful inventions were often proposed, such as "Keith should fix the garage doors". There were many descriptions of confused actions, together with incorrect and contradictory deductions.

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