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Oxford Cambridge and RSA

AS/A LEVEL GCE

Examiners' report

MATHEMATICS (MEI)

3895-3898, 7895-7898

4771/01 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 4771/01 series overview

Decision 1 (4771/01) can be taken as the one of the optional components for either AS/A Level Mathematics, or 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.

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 much of this content will form part of the optional components available in the reformed AS/A Level Further Mathematics specifications.

Many of the general comments from previous years' report resonate with this year's scripts. There were again issues with candidates answering their own question, rather than the specific question set on the examination paper. There were also issues with explanations that were not mathematically clear and/or relevant to the context of the question.

There was a good distribution of marks and no evidence that any omitted questions were due to insufficient time.

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

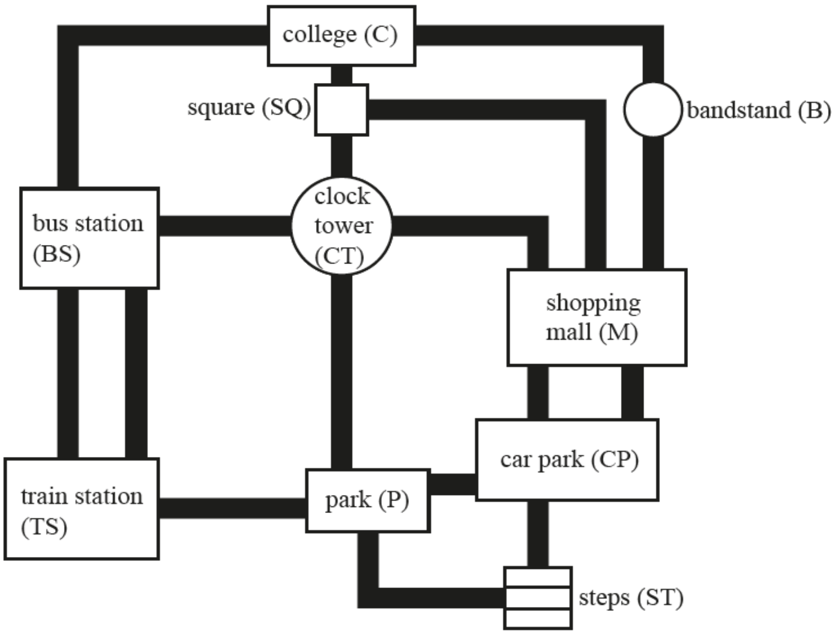
Key

	AfL	AfL If there is some guidance to offer for future teaching and learning practice.
	Misconception	

Section A

Question 1(i)

1 The diagram represents part of the centre of a town. Roads are shaded black.



(i) Draw a graph to represent this diagram. **[2]**

There was a significant minority of candidates that found the move from map to graph to be problematic. Some candidates were possibly confused by their work on CPA, wherein it is not permitted to have more than one arc between any given pair of vertices. In this question the repeated arcs between BS and TS and between M and CP are essential.

Question 1(ii)

A council cleaning team is to clean along each road.

(ii) Explain why it is not possible for the team to clean along each road without passing twice along at least one of the roads. **[2]**

There was a method mark here for identifying the relevant graph theory, odd nodes, Euler, et al. The accuracy mark was for being specific, identifying the odd nodes. In parts (iii) and (iv) many candidates identified the need to pair odd nodes, but then proceeded to ignore their own advice.

Question 1(iii)

You are to obtain a route for the team which repeats just one road.

(iii) State the road which will be repeated in your route. **[1]**

This mark was for modelling the requirement to repeat just one arc/road – so candidates needed to identify two adjacent odd nodes.

Question 1(iv)

(iv) Give a starting vertex and a finishing vertex for your route. **[1]**

As per part (iii), and to exclude vertices given in part (iii).

Question 1(v)

(v) Give your route. **[2]**

This part was straightforward for the majority of candidates that had successfully worked through the earlier parts, having already determined where to begin, where to end, and what to repeat.

Question 2(a)(i)

2 **(a)** Six parcels, A to F, with weights given in the table are to be packed into crates. Each crate has a capacity of 10 kg.

Parcel	A	B	C	D	E	F
Weight (kg)	1	6	4	2	3	4

(i) Use the first-fit algorithm to pack the parcels, saying how many crates are used. **[3]**

Many candidates thought that numbers, i.e. "weights", defined parcels. This cost them at least one mark.

A common error was to fail to return to crate 1 with parcel D, putting it into crate 2 instead.

Note that we are aware of the fact that kg is a unit of mass, not weight, but that the policy is to use the common everyday meaning for the quantity "weight".

Question 2(a)(ii)

(ii) Give an optimal solution. **[1]**

Only one mark here for non-algorithmic work – included to make a point.

Question 2(b)

(b) In the first pass of a bubble sort the first item is compared to the second item and they are swapped if they are in the incorrect order, then the second is compared with the third and they are swapped if necessary, and so on until the penultimate is compared to the last and they are swapped if necessary. In the second pass the process is repeated, but without the need to compare the last two items, and similarly for subsequent passes. In the final pass, only the two items in the first two positions are compared and swapped if necessary.

In a sale, a coat costs £78, a pair of gloves cost £26, a hat costs £35 and a scarf costs £12.

(i) Use a bubble sort to rearrange the items from the order given into increasing order of price. Show the list of costs after each pass of the algorithm. **[2]**

There was some confusion between a comparison and a pass. Redundant listings were ignored.

The majority of candidates were successful with this question.

Question 2(b)(ii)

(ii) How many comparisons and how many swaps were made in answering part **(i)**? **[2]**

Generally answered well.

Question 3(a)(i)

3 **(a)** Alice is playing Snakes and Ladders with a fair, 6-sided dice numbered 1 to 6. To get started she has to throw a 6. You are to simulate, ten times, how many throws it takes for her to get a 6.

(i) Give a rule for using one-digit random numbers to simulate throwing a six-sided dice. **[1]**

Many candidates answered their own question here. The question they answered was "Give a rule for using one-digit random numbers to simulate Alice repeatedly throwing the dice until she gets a 6".

Note that we are aware of the fact that the singular of "dice" is "die", but the modern standard use of "dice" as both singular and plural has been applied.

Question 3(a)(ii)

(ii) Use your rule with the 10 sets of one-digit random numbers given in the Printed Answer Book to complete 10 simulations of Alice repeatedly throwing the dice until she gets a 6. **[3]**

Many candidates did not apply their "ignore and draw again" rules. It is important that candidates followed their stated rule; if a problem with their rule is identified then this would indicate a refinement of the answer provided earlier.

Question 3(a)(iii)

(iii) Use your simulations to estimate the mean number of throws needed to get a 6. **[1]**

Some candidates lost the mark by rounding their one decimal place answer. It is important to recognise that, whilst the number of throws is discrete, the mean number of throws can be a decimal value. Consider, for example, the mean number of children per family in a given country. If the calculated value was 2.4, then approximations of 2 or 3 would be describing quite different population models.

Question 3(b)(i)

(b) **(i)** Give a most efficient rule for using two-digit random numbers to simulate throwing a six-sided dice. **[1]**

Many candidates answered their own question here. The question they answered was "Give a most efficient rule for using two-digit random numbers to simulate Alice repeatedly throwing the dice until she gets a 6".

Question 3(b)(ii)

(ii) Explain why it is more efficient to use two-digit random numbers than to use one-digit random numbers to simulate throwing a dice. **[1]**

The answer to this question is clear … fewer repetitions are needed. But see below …

Question 3(b)(iii)

(iii) Give a disadvantage of using two-digit random numbers compared to using one-digit random numbers. **[1]**

… but, arguably, each repetition takes longer.
(Most candidates assumed that the simulations were to be done by hand.)

Section B

Question 4(i)

4 A meal is to be prepared and eaten. There will be two courses, meat pie with vegetables, followed by apple crumble with custard. The activities involved and their durations and precedences are shown in the table.

Activity		Duration (mins)	Immediate predecessors
A	Prepare the vegetables	10	–
B	Defrost the meat pie	5	–
C	Make the apple crumble	15	–
D	Prepare the custard	5	–
E	Heat the oven	10	–
F	Heat the meat pie	20	B, E
G	Cook the vegetables	15	A
H	Cook the apple crumble	15	C, E
I	Heat the custard	5	D
J	Eat the first course	15	F, G
K	Eat the second course	15	H, I, J

(i) Draw an activity-on-arc precedence network for preparing and eating the meal. **[5]**

The crucial point in this question is the need for dummy activities to model the dependencies of B and C on E.

Question 4(ii)

(ii) Complete a forward pass and a backward pass to determine the minimum completion time and the critical activities. **[6]**

Candidates should be prepared to revise their answer to part (i) if problems encountered when completing the backward pass.

Question 4(iii)

The meal is to be prepared and eaten by two people.

Activities A, B, C and D each require one person and cannot be split.

Activities E, F, G, H and I require no labour.

Activities J and K each require 2 people.

(iii) Produce a schedule for two people to prepare and eat the meal in the minimum time. **[4]**

Candidates found this difficult. Many did not indicate staffing. Some produced answers which were not consistent with their answer to part (ii).

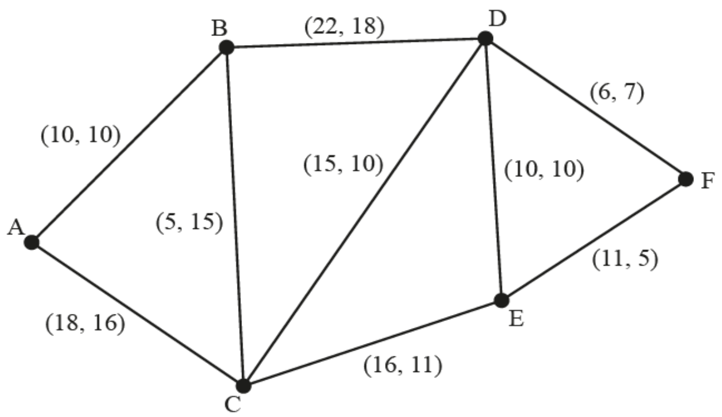
Question 4(iv)

(iv) Explain why employing extra help cannot shorten the minimum time found in part **(iii)**. **[1]**

Examiners were looking for a response which included the fact that activities on the critical path could not be completed more quickly given extra staffing.

Question 5(i)

5 The network shows 6 locations with connecting arcs. Each arc has a pair of numbers associated with it. The first gives the cost and the second gives the distance involved in proceeding along that arc.



Europa uses Dijkstra's algorithm to find the cheapest route and cheapest cost from A to F.

(i) Show Europa's calculations and give her cheapest route and cheapest cost. **[4]**

This part proved to be routine for the majority of candidates – most did well on it.

Question 5(ii)

Milo uses Dijkstra's algorithm to find the shortest route and shortest distance from A to F.

(ii) Show Milo's calculations and give his shortest route and shortest distance. **[4]**

This part was also answered well by the majority of candidates.

Question 5(iii)

Europa and Milo argue about which of their routes is best. Henry suggests that they compromise by using cost per unit distance as a measure.

(iii) Find the cost per unit distance of Europa's route and the cost per unit distance of Milo's route. **[2]**

The calculation of "cost per unit distance" proved more problematic than the previous parts – perhaps too many "ratio triangles" were littering their memories.

Question 5(iv)

(iv) Explain why Henry cannot use Dijkstra's algorithm to find a route with the minimum cost per unit distance. **[1]**

This was, arguably, the most difficult mark on the paper. Some very good candidates answered that it is a (whole) path property – not quite sufficient for a convincing explanation, but good enough for the mark.

Other candidates were able to argue that ratios are not additive.

Question 5(v)

Bridget suggests that both Europa and Milo find their minimum spanning trees, and that they then use arcs within their trees to connect A to F.

(v) Use Prim's algorithm starting at A to find Europa's minimum spanning tree, making clear your use of the algorithm and drawing your tree. **[2]**

It is important that candidates show a clear application of the correct algorithm in order to gain full credit. Many candidates did not show their order of including vertices.

Question 5(vi)

(vi) Use Kruskal's algorithm to find Milo's minimum spanning tree, making clear your use of the algorithm and drawing your tree. **[2]**

As mentioned in part (i), a clear application of the algorithm is needed in this part – no order of arc inclusion, no mark.

Question 5(vii)

(vii) Why will Milo not like Bridget's suggestion? **[1]**

Candidates need to stick to the question and to the maths therein when answering this type of question.

Question 6(i)

6 A council owns 50 acres of land on the boundary between an urban area and a rural area. The council is considering strategic plans for the land.

The council could sell land with planning permission for housing at £200 000 per acre. The council has already limited the amount of such development on this land to no more than 10 acres.

Land can also be developed for recreational use. The capital cost of this (landscaping, etc) will be £5000 per acre.

The council will invest the difference between what it gains from selling land for housing and what it spends on developing land for recreational use. Any money that the council invests will earn interest at 1.5% per year. The investment income must be sufficient to cover the cost of maintenance of the recreational land, which will be £500 per acre per year.

(i) Define appropriate variables. Using those variables, formulate and simplify three inequalities to model the constraints described above. **[6]**

The majority of candidates were able to model this scenario successfully; however, a significant number forgot to define their variables clearly.

Question 6(ii)

(ii) Draw a graph representing the feasible region for the council's decision problem. **[5]**

Candidates demonstrated good graph-drawing skills.

Question 6(iii)

(iii) Give the four solutions corresponding to the four vertices of your feasible region. For each of them state the circumstances in which the council might choose that solution. **[3]**

This part proved challenging for the majority of candidates.

Question 6(iv)

The council decides to sell 10 acres for housing development, but, before it can do so, a benefactor gives the council another 15 acres on an adjoining plot.

(iv) How much of the remaining 55 acres can be developed for recreational use? **[2]**

In order to succeed on this final part, candidates needed to have that last inequality specified and simplified.

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