OCR
RECOGNISING ACHIEVEMENT

Thursday 6 June 2013 – Morning

AS GCE MATHEMATICS (MEI)

4771/01 Decision Mathematics 1

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4771/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

4715890613

INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found in the centre of the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).
- Use black ink. HB pencil may be used for graphs and diagrams only.
- Read each question carefully. Make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- You are permitted to use a graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

- The number of marks is given in brackets **[ ]** at the end of each question or part question on the Question Paper.
- You are advised that an answer may receive **no marks** unless you show sufficient detail of the working to indicate that a correct method is being used.
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **8** pages. Any blank pages are indicated.

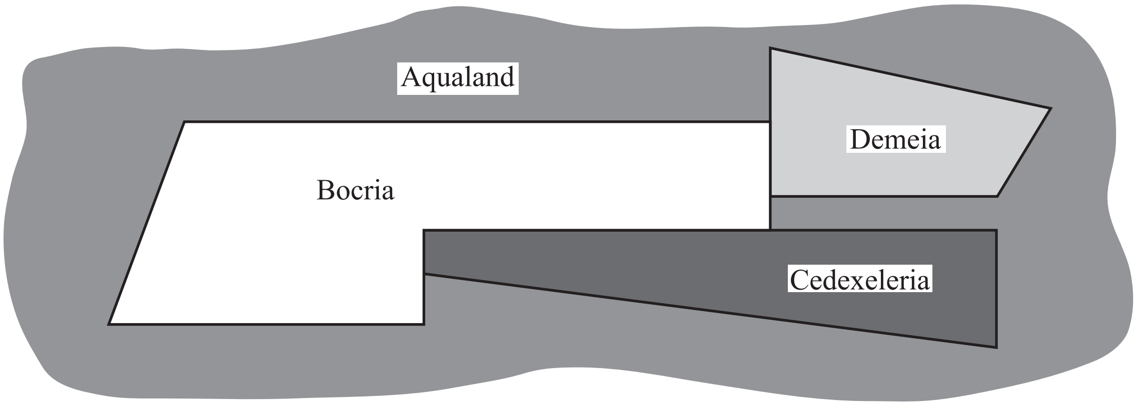
INSTRUCTIONS TO EXAMS OFFICER/INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

Section A (24 marks)

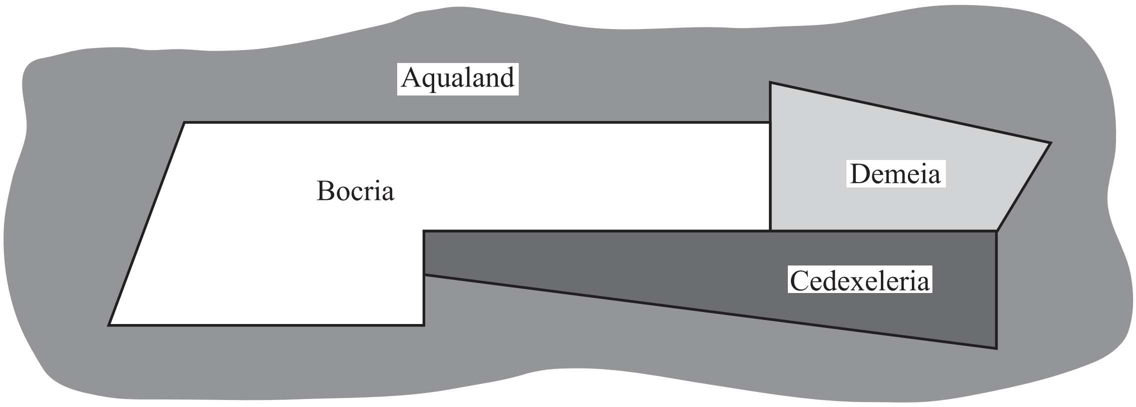
1 The adjacency graph for a map has a vertex for each country. Two vertices are connected by an arc if the corresponding countries share a border.

(i) Draw the adjacency graph for the following map of four countries. The graph is planar and you should draw it with no arcs crossing. **[3]**



(ii) Number the regions of your planar graph, including the outside region. Regarding the graph as a map, draw its adjacency graph. **[2]**

(iii) Repeat parts **(i)** and **(ii)** for the following map. **[3]**



2 The instructions labelled 1 to 7 describe the steps of a sorting algorithm applied to a list of six numbers.

1 Let i equal 1.
2 Repeat lines 3 to 7, stopping when i becomes 6.
3   Let j equal 1.
4   Repeat lines 5 and 6, until j becomes $7 - i$.
5   If the jth number in the list is bigger than the $(j+1)$th, then swap them.
6   Let the new value of j be $j+1$.
7   Let the new value of i be $i+1$.

(i) Apply the sorting algorithm to the list of numbers shown below. Record in the table provided the state of the list after each pass. Record the number of comparisons and the number of swaps that you make in each pass. (The result of the first pass has already been recorded.) **[5]**

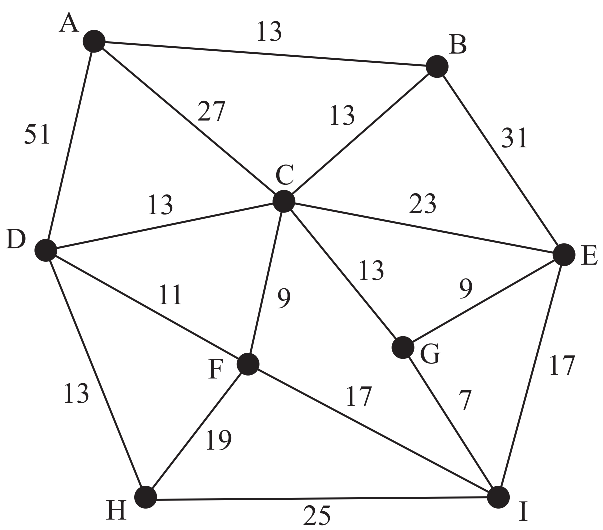
List: 9 11 7 3 13 5

(ii) Suppose now that the list is split into two sublists, {9, 11, 7} and {3, 13, 5}. The sorting algorithm is adapted to apply to three numbers, and is applied to each sublist separately. This gives {7, 9, 11} and {3, 5, 13}.

How many comparisons and swaps does this need? **[2]**

(iii) How many further swaps would the original algorithm need to sort the revised list {7, 9, 11, 3, 5, 13} into increasing order? **[1]**

3 The network below represents a number of villages together with connecting roads. The numbers on the arcs represent distances (in miles).



(i) Use Dijkstra's algorithm to find the shortest routes from A to each of the other villages.

Give these shortest routes and the corresponding distances. **[6]**

Traffic in the area travels at 30 mph. An accident delays all traffic passing through C by 20 minutes.

(ii) Describe how the network can be adapted and used to find the fastest journey time from A to F. **[2]**

Section B (48 marks)

4 Simon has a list of tasks which he has to complete before leaving his home to go on holiday. The table lists those tasks, their durations, and their immediate predecessors. The durations assume that only one person is working on each activity.

Task		Duration (minutes)	Immediate predecessor(s)
A	pack suitcases	30	–
B	make up beds	10	–
C	clean upstairs	20	A, B
D	wash upstairs floors	10	C
E	bring in outside furniture	15	–
F	close down central heating	5	–
G	disconnect TV system	5	–
H	load car	10	A
I	clean downstairs	25	D, F
J	wash downstairs floors	10	I
K	wash patios	15	E
L	lock up	5	G, H, J, K

(i) Draw an activity on arc network for these activities. **[5]**

(ii) Mark on your diagram the early time and the late time for each event. Give the minimum completion time and the critical activities. **[6]**

(iii) Explain why Simon will require help if the tasks are all to be completed within the minimum time. **[1]**

Simon's friend offers to help. They share the tasks between them so that each task is completed by only one person.

(iv) Produce a cascade chart to show how the tasks can be shared between Simon and his friend, and scheduled, so that the project can be completed in the minimum time. **[4]**

5 Angelo manages a winter sports shop in a ski resort. He needs to decide how many snowboards and how many pairs of skis to purchase for the coming season to maximise his profit from hiring them out.

He has space for at most 250 snowboards and 500 pairs of skis.

Because there are more skiers than snowboarders Angelo will purchase at least 10% more pairs of skis than snowboards.

Both snowboards and skis need servicing, and his servicing facility can cope with no more than 600 units (ie snowboards or pairs of skis).

His expected profit from buying and renting out a snowboard is €40 for the season, and his expected profit from buying and renting out a pair of skis is €50 for the season.

(i) Define appropriate variables, construct inequality constraints, and draw a graph representing the feasible region for Angelo's decision problem. **[10]**

(ii) Give the objective function and find the solution which will give the maximum profit. **[3]**

Angelo considers increasing the cost of snowboard hire so that snowboard profits rise enough to change the optimal solution.

(iii) By how much will snowboard profits have to rise to change the optimal solution? **[1]**

Angelo increases the cost of snowboard hire and creates extra storage space for snowboards.

(iv) What is the greatest number of extra snowboards it is worth Angelo accommodating? **[2]**

[Question 6 is printed overleaf.]

6 The time intervals between customers arriving at the queue for the till in a small supermarket are modelled by the following probability distribution.

Time interval (mins)	1	2	3	4
Probability	0.3	0.5	0.1	0.1

(i) Give a rule for using 1-digit random numbers to simulate inter-arrival times. **[2]**

(ii) Use the nine random digits provided to simulate nine inter-arrival times. Hence, assuming that the first customer arrives at the queue at time 0, give the arrival times of the first ten customers. **[3]**

Customers shop for single items, light loads, medium loads or heavy loads. These require respectively 0.1, 0.25, 1 and 2 minutes on average to process at the till. The proportions in each category are $\frac{1}{7}, \frac{2}{7}, \frac{3}{7}$ and $\frac{1}{7}$ respectively.

(iii) Give an efficient rule for using 2-digit random numbers to simulate till processing times. **[3]**

(iv) Use the 2-digit random numbers provided to simulate the till processing times for the first ten customers. There are more random numbers provided than you will need. **[2]**

60% of customers pay by credit card and 40% pay by cash. A credit card transaction takes 1 minute on average, and a cash transaction takes 0.25 minutes.

(v) Give an efficient rule for using 1-digit random numbers to simulate payment times. **[1]**

(vi) Use the ten random digits provided to simulate the payment times for the first ten customers. **[1]**

(vii) Use your answers to parts **(ii)**, **(iv)** and **(vi)** to find the departure times for the first ten customers. **[2]**

The shop owner is considering installing a second till which does not have credit card facilities. All customers paying cash will use this till.

(viii) Repeat part **(vii)** under this proposed new arrangement. **[2]**

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RECOGNISING ACHIEVEMENT

Thursday 6 June 2013 – Morning

AS GCE MATHEMATICS (MEI)

4771/01 Decision Mathematics 1

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Candidate forename		Candidate surname	

Centre number						Candidate number				

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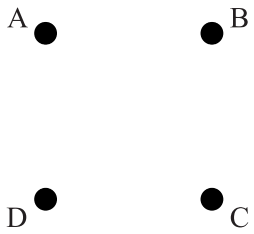
Section A (24 marks)

1 (i)	
1 (ii)	
1 (iii)	

2 (i)

*i*th pass

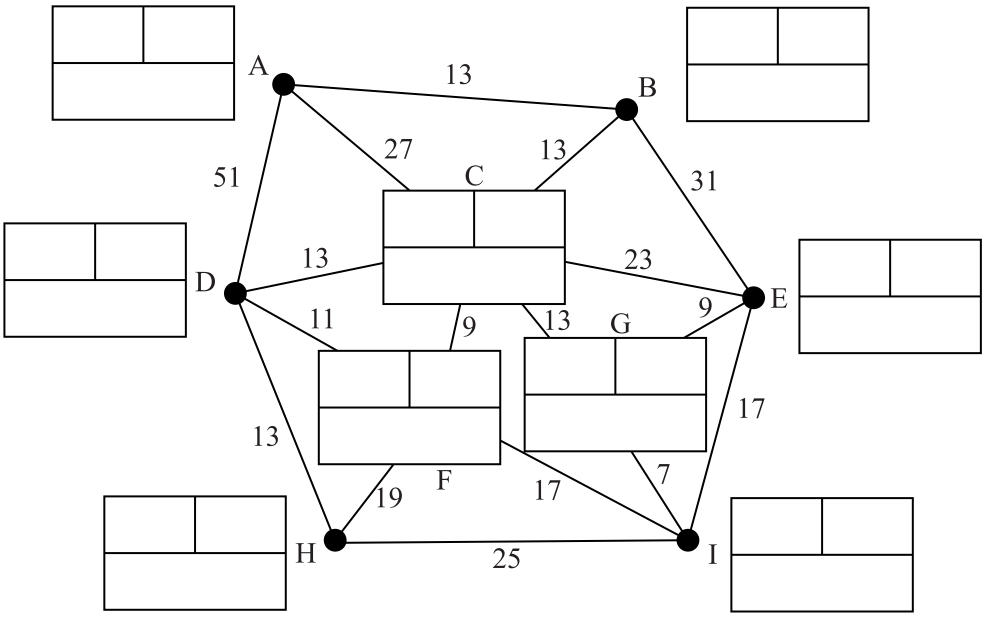
i=1	9	7	3	11	5	13
i=2						
i=3						
i=4						
i=5						

comparisons	swaps
5	3

2 (ii)

2 (iii)

3 (i)



From A to	Shortest route	Distance (miles)
B		
C		
D		
E		
F		
G		
H		
I		

There is a spare copy of the network and table on page 10.

3 (ii)

Section B (48 marks)

4 (i) & (ii)	
4 (iii)	
4 (iv)	**There is a spare copy of this grid on page 11.**

5 (i)

There is a spare copy of this graph paper on page 12.

5 (ii)	
5 (iii)	
5 (iv)	

6 (i)

6 (ii)

customer number	1	2	3	4	5	6	7	8	9	10
random number		5	3	2	4	7	9	1	1	8
time interval (mins)										
arrival time	0									

6 (iii)

6 (iv)

Random numbers: 23 15 98 01 32 45 47 86 71 17
83 31 45 37 05 21 90 06 54 22

customer number	1	2	3	4	5	6	7	8	9	10
processing time										

6 (v)

6 (vi)

customer number	1	2	3	4	5	6	7	8	9	10
random number	8	3	0	1	4	0	2	5	7	6
payment time										

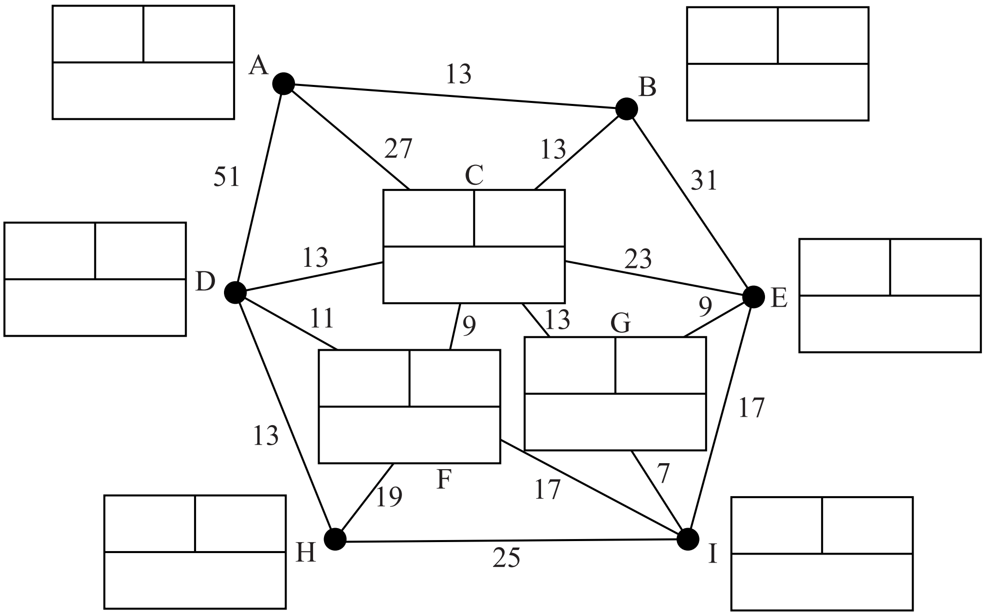
6 (vii)

customer number	1	2	3	4	5	6	7	8	9	10
arrival										
departure										

6 (viii)

customer number	1	2	3	4	5	6	7	8	9	10
arrival										
departure										

3 (i) **Spare copy of network and table for 3 (i).**



From A to	Shortest route	Distance (miles)
B		
C		
D		
E		
F		
G		
H		
I		

4 (iv)	**Spare copy of grid for 4 (iv).**

PLEASE DO NOT WRITE IN THIS SPACE

5 (i)	**Spare copy of graph paper for 5 (i).**

RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced Subsidiary GCE

Unit **4771:** Decision Mathematics 1

Mark Scheme for June 2013

1. **Annotations and abbreviations**

Annotation in scoris	**Meaning**
✓and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	
Other abbreviations in mark scheme	**Meaning**
E1	Mark for explaining
U1	Mark for correct units
G1	Mark for a correct feature on a graph
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

2. **Subject-specific Marking Instructions for GCE Mathematics (MEI) Decision strand**

a Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

b An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

c The following types of marks are available.

M
A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A
Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B
Mark for a correct result or statement independent of Method marks.

E

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.

e The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

f Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

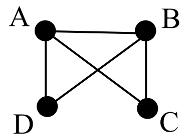
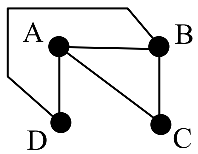
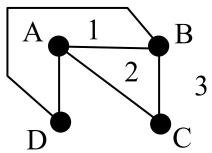
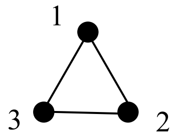
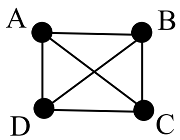
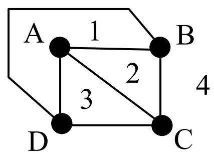
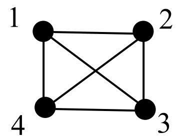
If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

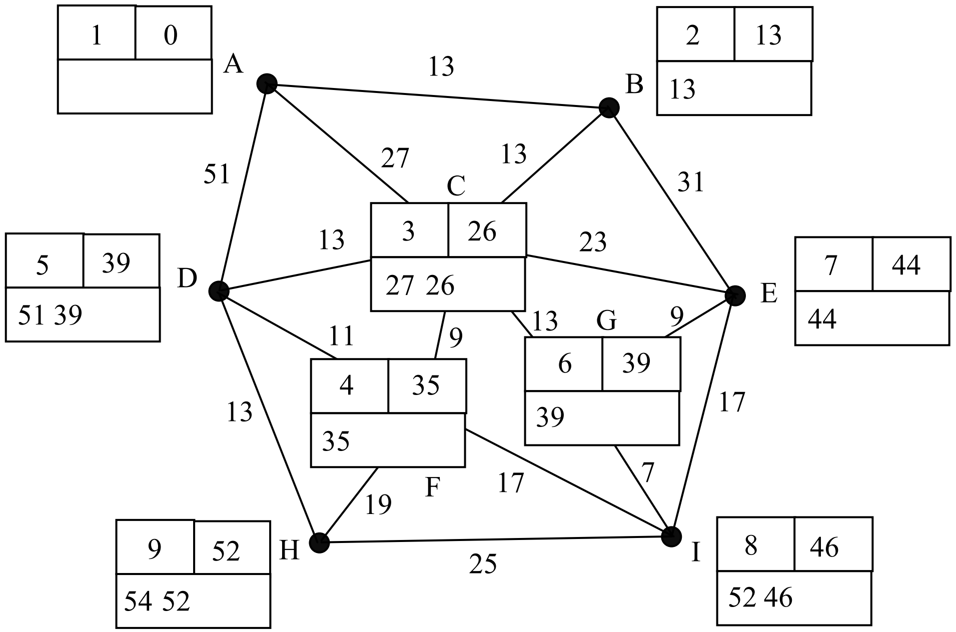
Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

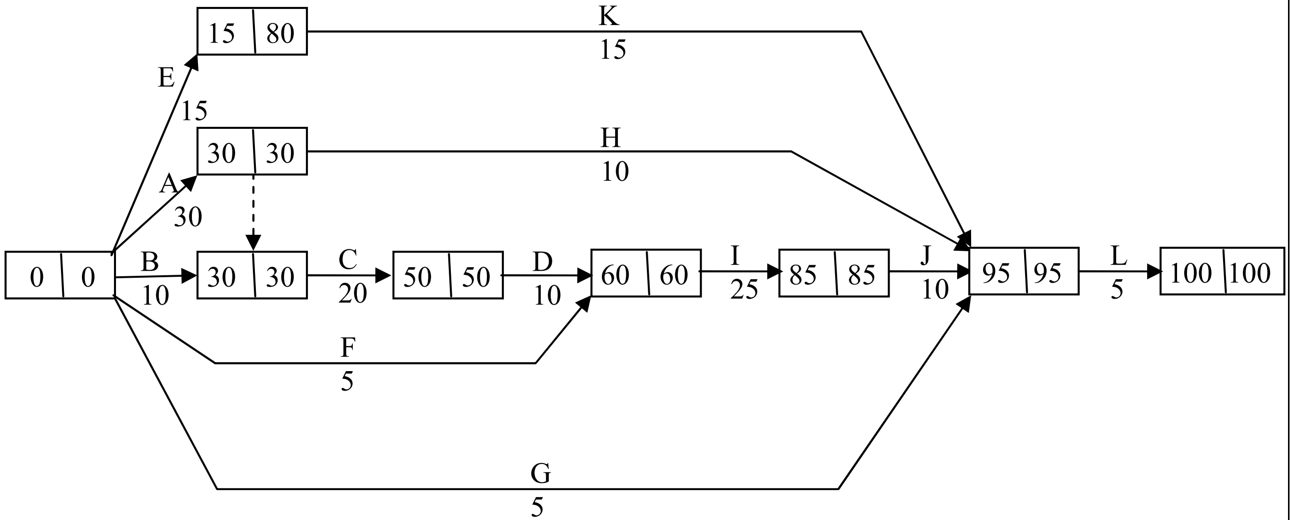
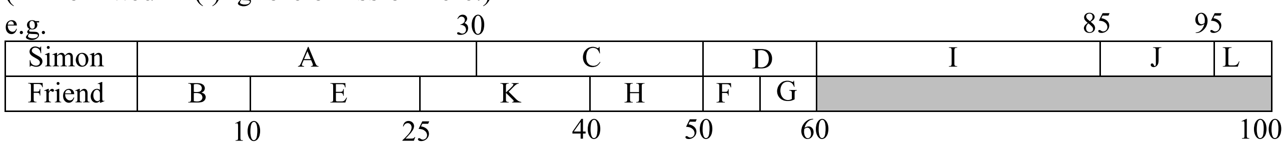
Question			Answer	Marks	Guidance
1	(i)		 e.g. 	M1 A1 B1 [3]	simple and connected but not complete. (Ignore directions) cao planar - cao
1	(ii)		e.g.  	M1 A1 [2]	exactly 3 vertices cao
1	(iii)		  	B1 M1 A1 [3]	complete graph on 4 letters 4 regions cao (planar OK)

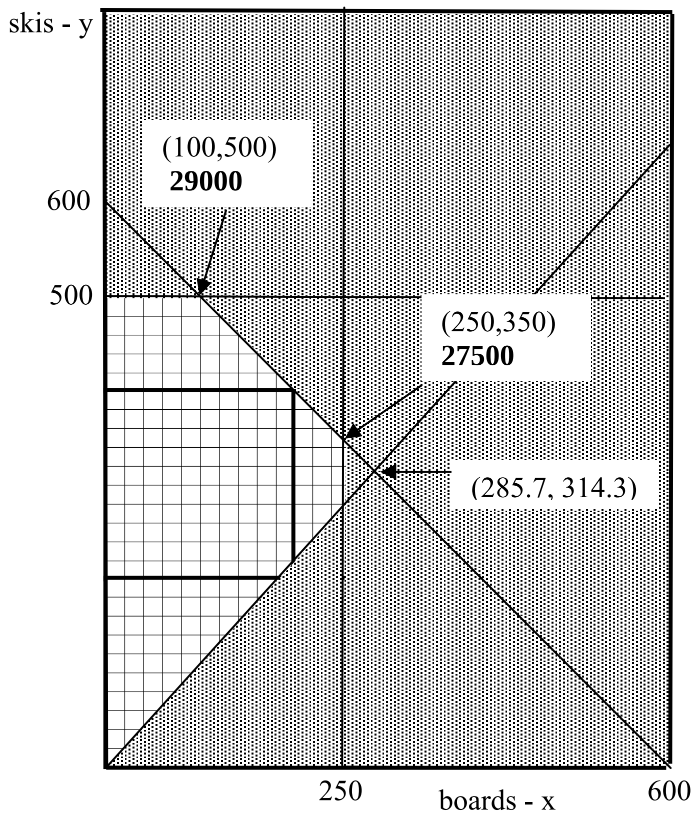
<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2</td><td>(i)</td><td></td><td>
<table>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>comps</td><td>swaps</td></tr>
<tr><td>i=1</td><td>9</td><td>7</td><td>3</td><td>11</td><td>5</td><td>13</td><td></td><td>5</td><td>3</td></tr>
<tr><td>i=2</td><td>7</td><td>3</td><td>9</td><td>5</td><td>11</td><td>13</td><td></td><td>4</td><td>3</td></tr>
<tr><td>i=3</td><td>3</td><td>7</td><td>5</td><td>9</td><td>11</td><td>13</td><td></td><td>3</td><td>2</td></tr>
<tr><td>i=4</td><td>3</td><td>5</td><td>7</td><td>9</td><td>11</td><td>13</td><td></td><td>2</td><td>1</td></tr>
<tr><td>i=5</td><td>3</td><td>5</td><td>7</td><td>9</td><td>11</td><td>13</td><td></td><td>1</td><td>0</td></tr>
</table>
</td><td>B1
B1
B1

B1
B1
[5]</td><td>i=2 row OK
i=3 row OK FT
i=4 and 5 rows OK cao

comparisons
swaps</td></tr>
<tr><td>2</td><td>(ii)</td><td></td><td>comparisons 6
swaps 3</td><td>B1
B1
[2]</td><td>cao (OK if in 2 parts)
cao (OK if in 2 parts)</td></tr>
<tr><td>2</td><td>(iii)</td><td></td><td>further swaps 6</td><td>B1
[1]</td><td>cao</td></tr>
</table>

Question			Answer	Marks	Guidance
3	(i)		 AB 13 ABC 26 ABCD 39 ABE 44 ABCF 35 ABCG 39 ABCDH 52 ABCGI 46	B1 B1 B1 B1 B1 B1 **[6]**	Dijkstra – C correct other working values order of labelling labels Note that D and G could be labelled in the reverse order. first 4 pairs second 4 pairs
3	(ii)		Turn distances to times throughout the network. Add 10 mins to every arc incident upon C. (or do Dijkstra twice, once with C deleted, and compare with the adjusted time through C)	E1 E1 **[2]**	Explanations needed, not answers any correct logic

Question		Answer	Marks	Guidance
4	(i) & (ii)	 Minimum completion time = 100 minutes Critical activities are A, C, D, I, J and L	M1 A1 A1 A1 A1 **[5]** M1 A1 M1 A1 B1 B1 **[6]**	activity on arc single start and end A, B, C OK D, F, I OK rest OK forward pass (must have at least one join correct FT backward pass (must have at least one burst correct) FT cao cao
4	(iii)	e.g. Critical activities (100 mins) + others. e.g. B has to be done whilst A is underway.	B1 **[1]**	Needs a comparison of times, possibly implied.
4	(iv)	(If L omitted in (i) ignore omission here.) e.g. 	M1 A1 A1 A1 **[4]**	diagram like this or attempted cascade ... no more than 1 omitted activity nowhere needing more than 2 people precedences correct fully correct, inc who does what

Question			Answer	Marks	Guidance
5	(i)		e.g.		
			Let x be the number of snowboards	B1	
			Let y be the number of (pairs of) skis	B1	or vice-versa of course
			$x + y \leq 600$	B1	
			$x \leq 250$ and $y \leq 500$	B1	both
			$1.1x \leq y$	B1	
				B1 B1 B1 B1	FT horizontal line FT vertical line FT positive slope line x+y = 600 Note ... error tolerance of +/- half a small square within feasible region.
				B1	shading ... follow any pentagon bounded by the y-axis, a horizontal line, a vertical line, a negatively inclined line and a positively inclined line
				[10]	

Question			Answer	Marks	Guidance
5	(ii)		Objective = 40x + 50y 29000 at (100,500) 27500 at (250,350) Solution ... 100 snowboards and 500 pairs of skis	B1 M1 A1 **[3]**	objective considering profits at the two indicated points of their pentagon (or using a profit line) cao www
5	(iii)		€10 or more	B1 **[1]**	cao (allow €51 etc)
5	(iv)		35 snowboards	M1 A1 **[2]**	moving to appropriate new feasible point on their negatively inclined line cao... integer! (allowing 30 to 40 for graphical inaccuracy)

Question		Answer	Marks	Guidance
6	(i)	e.g. 0, 1, 2 $\rightarrow$ 1 3, 4, 5, 6, 7 $\rightarrow$ 2 8 $\rightarrow$ 3 9 $\rightarrow$ 4	M1 A1 **[2]**	either 3 numbers for 1 or 5 numbers for 2 all proportions correct
6	(ii)	random number: 5, 3, 2, 4, 7, 9, 1, 1, 8 time interval (mins): 2, 2, 1, 2, 2, 4, 1, 1, 3 arrival times: 0, 2, 4, 5, 7, 9, 13, 14, 15, 18	M1 A1 B1 **[3]**	all outcomes achieved with first 2 correct for their rule all correct FT accumulation
6	(iii)	e.g. 00 – 13 $\rightarrow$ 0.1 14 – 41 $\rightarrow$ 0.25 42 – 83 $\rightarrow$ 1 84 – 97 $\rightarrow$ 2 98, 99 ignore and “redraw”	M1 A1 A1 **[3]**	ignore some proportions correct efficient (fewer than 7 rejected)
6	(iv)	random number: 23, 15, 01, 32, 45, 47, 86, 71, 17, 83 processing time: 0.25, 0.25, 0.1, 0.25, 1, 1, 2, 1, 0.25, 1	M1 A1 **[2]**	first 4 customers correct for their rule all correct FT
6	(v)	e.g. 0 – 5 $\rightarrow$ 1 6 – 9 $\rightarrow$ 0.25	B1 **[1]**	
6	(vi)	random number: 8, 3, 0, 1, 4, 0, 2, 5, 7, 6 payment time: 0.25, 1, 1, 1, 1, 1, 1, 1, 0.25, 0.25	B1 **[1]**	FT
6	(vii)	arrival: 0, 2, 4, 5, 7, 9, 13, 14, 15, 18 departure: 0.5, 3.25, 5.1, 6.35, 9, 11, 16, 18, 18.5, 19.75	M1 A1 **[2]**	deals with a wait correctly all correct FT
6	(viii)	arrival: 0, 2, 4, 5, 7, 9, 13, 14, 15, 18 departure: 0.5, 3.25, 5.1, 6.35, 9, 11, 16, 18, 15.5, 19.25	M1 A1 **[2]**	deals with last 3 correctly all correct FT

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June 2013

4771 Decision Mathematics 1

General Comments

More than ever on this question paper, difficulties with the mathematics coupled with difficulties in written expression, were intertwined. Clarity of thought and clarity of expression go ‘hand in glove’. Parts 3 (ii) and 4 (iii) were found by the candidates to be part particularly testing. Conversely, the responses to 6(vii) and 6(viii) were encouraging, showing that a good number of candidates were thinking well, right up to the end of the question paper. Some candidates were stretched for time, but it is difficult to disentangle that from inefficiencies of approach – see the comments below on Q2 parts (ii) and (iii).

Comments on Individual Questions

1) This question differentiated very well. Lower attaining candidates found difficulty getting to grips with the instructions. Higher attaining candidates breezed through it. There were some instances of rubbing lines out and trying again. If candidates do this then they should take very great care to ensure that their final answer is clear. It is the candidate’s responsibility to communicate clearly.

2) Candidates are required to know bubble sort. Those who recognised it had an easier found the question easier to deal with, but were at risk of losing marks by not continuing to the end, as the algorithm specifies. Leaving the last line blank cost one of the three marks for the procedure, the mark for the numbers of comparisons and the mark for the numbers of swaps.

   Some candidates clearly spent an inordinately long time on parts (ii) and (iii), with only two marks and one mark available respectively. Candidates need to move on if their approach is taking longer than is commensurate with the marks allocated.

3) Part (i) of this question was answered well by candidates at all attainment levels. Everyone understood what is required in an application of Dijkstra.

   Part (ii) turned out to be very challenging. Most candidates scored zero, a few scored one, and very few completely correct solutions were seen. It had been expected that most candidates would score at least one, since the first mark was for realising that the network needed adapting to show times rather than distances. The majority of candidates did not try to modify their networks. They attempted to find the new solution – emphatically not what had been asked. Many who did attempt an adaptation turned the delay into an equivalent extra mileage, but then gave no subsequent indication that they needed to convert their shortest route into a fastest journey time, as had been requested.

   Dealing with the delay was a challenge. Adding 20 minutes to each arc through C gives a 40 minute delay on routes through C. One cannot add 20 to the “ins” or 20 to the “outs” since one does not know which will be which. 10 minutes extra on each arc incident on C is what is required.
   .
   There is an alternative - add 20 minutes on the time taken for the shortest route from part (i), and then apply Dijkstra to the time-weighted network with C and its arcs deleted. Then choose the better of the two.

   It was distressing to read, so many times, candidates who wished to add 20 minutes or 10 miles to C, thus showing a complete lack of understanding of the nature of a network.

4) Parts (i) and (ii) produced good scores for nearly all candidates, although there were more examples of activity-on-node than have been seen of late. One or two candidates had networks with arcs labelled with activities, but then with two unspecified times attached to each activity, rather than two times attached to each event. Their times earned no marks. Activity “L” was often omitted.

   There was only one “burst” at which the method mark for the backward pass could be awarded, this also accessing an accuracy mark. This was at A’s “j” event / H’s “i” event. The late event time should have been 30, but 85 was often seen.

   There were many instances of candidates inserting unnecessary dummies, e.g. between the end of G and the beginning of L. This does not incur any penalty, but there is then an extra event needed, with its early time and its late time. The late time should be the same as the late time for L’s “i” event, but many candidates lost the backward pass accuracy mark by subtracting the activity duration, i.e. by subtracting G’s duration in this example.

   Whilst some good scores were seen, the quality seen differed greatly. The worst case scenarios had diagrams wandering over the page with connections which looked like tangled fishing lines. The best were neat, crisp and clear – the above point about clarity of thought and clarity of expression being clear to see.

   The mark in part (iii) was earned by few candidates. The vast majority of answers could be paraphrased either by “Because he won’t complete within the minimum time without help” or by “Because two activities both have to be done at the same time”. Both leave the question unanswered. Arguably the best answer, that there are 160 minutes of work to be done in 100 minutes of elapsed time, was seen from only a very few candidates.

   There were candidates, when answering part (iv,) who tried to schedule all non-critical activities to start at time 0. There were those who, whilst scheduling correctly, failed to show who was doing what.

5) It would be unusual if the report on the LP question did not start by stressing the importance of variable definition. The usual requirement for ’number of’ is not an arbitrary ‘hobby-horse’, but reflects the need that variables be unambiguously defined. This was well illustrated in this paper where there was the added complication of having both snowboards and **pairs** of skis. Suppose we had a report giving information about Marco's purchase of snowboards ... we are told how many, the cost and the delivered weight. So "x=snowboards" is not sufficiently specific ... it could be the number, the cost or the weight. The same report also has information about skis ... number of pairs, the cost and the delivered weight. In this case "y=pairs of skis" is unambiguous, and it was therefore allowed.

   The ’10% more’ constraint posed some difficulties, though not so many as might have been expected.

   The graph was often drawn well, although the gradient of the “10% more” constraint did not always match the candidate’s algebra.

   Part (ii), the optimisation, was done well. Parts (iii) and (iv), the post-optimal analysis, proved to be more of a challenge. In particular, in part (iii) very many candidates produced the answer €6 from the computation (29000 –27500)/250 ... the reader might try to see why.

6) No matter how candidates twisted and turned in their definitions of their random variables, and there were many twists and turns, they all ended up being tested on the same issues – and most did very well indeed. The quality of answers was high. The denouement in parts (vii) and (viii) was pleasingly well handled by many candidates, even though it had been expected that it would be testing.

For a description of how UMS marks are calculated see:
www.ocr.org.uk/learners/ums_results.html

Unit level raw mark and UMS grade boundaries June 2013 series

AS GCE / Advanced GCE / AS GCE Double Award / Advanced GCE Double Award

GCE Mathematics (MEI)

		Max Mark	a	b	c	d	e	u
4751/01 (C1) MEI Introduction to Advanced Mathematics	Raw	72	62	56	51	46	41	0
	UMS	100	80	70	60	50	40	0
4752/01 (C2) MEI Concepts for Advanced Mathematics	Raw	72	54	48	43	38	33	0
	UMS	100	80	70	60	50	40	0
4753/01 (C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	58	52	46	40	33	0
4753/02 (C3) MEI Methods for Advanced Mathematics with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4753/82 (C3) MEI Methods for Advanced Mathematics with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
4753 (C3) MEI Methods for Advanced Mathematics with Coursework	UMS	100	80	70	60	50	40	0
4754/01 (C4) MEI Applications of Advanced Mathematics	Raw	90	66	59	53	47	41	0
	UMS	100	80	70	60	50	40	0
4755/01 (FP1) MEI Further Concepts for Advanced Mathematics	Raw	72	63	57	51	45	40	0
	UMS	100	80	70	60	50	40	0
4756/01 (FP2) MEI Further Methods for Advanced Mathematics	Raw	72	61	54	48	42	36	0
	UMS	100	80	70	60	50	40	0
4757/01 (FP3) MEI Further Applications of Advanced Mathematics	Raw	72	60	52	44	36	28	0
	UMS	100	80	70	60	50	40	0
4758/01 (DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	62	56	51	46	40	0
4758/02 (DE) MEI Differential Equations with Coursework: Coursework	Raw	18	15	13	11	9	8	0
4758/82 (DE) MEI Differential Equations with Coursework: Carried Forward Coursework Mark	Raw	18	15	13	11	9	8	0
4758 (DE) MEI Differential Equations with Coursework	UMS	100	80	70	60	50	40	0
4761/01 (M1) MEI Mechanics 1	Raw	72	57	49	41	33	25	0
	UMS	100	80	70	60	50	40	0
4762/01 (M2) MEI Mechanics 2	Raw	72	50	43	36	29	22	0
	UMS	100	80	70	60	50	40	0
4763/01 (M3) MEI Mechanics 3	Raw	72	64	56	48	41	34	0
	UMS	100	80	70	60	50	40	0
4764/01 (M4) MEI Mechanics 4	Raw	72	56	49	42	35	29	0
	UMS	100	80	70	60	50	40	0
4766/01 (S1) MEI Statistics 1	Raw	72	55	48	41	35	29	0
	UMS	100	80	70	60	50	40	0
4767/01 (S2) MEI Statistics 2	Raw	72	58	52	46	41	36	0
	UMS	100	80	70	60	50	40	0
4768/01 (S3) MEI Statistics 3	Raw	72	61	55	49	44	39	0
	UMS	100	80	70	60	50	40	0
4769/01 (S4) MEI Statistics 4	Raw	72	56	49	42	35	28	0
	UMS	100	80	70	60	50	40	0
4771/01 (D1) MEI Decision Mathematics 1	Raw	72	58	52	46	40	35	0
	UMS	100	80	70	60	50	40	0
4772/01 (D2) MEI Decision Mathematics 2	Raw	72	58	52	46	41	36	0
	UMS	100	80	70	60	50	40	0
4773/01 (DC) MEI Decision Mathematics Computation	Raw	72	46	40	34	29	24	0
	UMS	100	80	70	60	50	40	0
4776/01 (NM) MEI Numerical Methods with Coursework: Written Paper	Raw	72	56	50	44	38	31	0
4776/02 (NM) MEI Numerical Methods with Coursework: Coursework	Raw	18	14	12	10	8	7	0
4776/82 (NM) MEI Numerical Methods with Coursework: Carried Forward Coursework Mark	Raw	18	14	12	10	8	7	0
4776 (NM) MEI Numerical Methods with Coursework	UMS	100	80	70	60	50	40	0
4777/01 (NC) MEI Numerical Computation	Raw	72	55	47	39	32	25	0
	UMS	100	80	70	60	50	40	0
4798/01 (FPT) Further Pure Mathematics with Technology	Raw	72	57	49	41	33	26	0
	UMS	100	80	70	60	50	40	0

GCE Statistics (MEI)

		Max Mark	a	b	c	d	e	u
G241/01 (Z1) Statistics 1	Raw	72	55	48	41	35	29	0
	UMS	100	80	70	60	50	40	0
G242/01 (Z2) Statistics 2	Raw	72	55	48	41	34	27	0
	UMS	100	80	70	60	50	40	0
G243/01 (Z3) Statistics 3	Raw	72	56	48	41	34	27	0
	UMS	100	80	70	60	50	40	0