OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

MATHEMATICS (MEI)

Decision Mathematics 2

4772

QUESTION PAPER

Candidates answer on the printed answer book.

OCR supplied materials:
- Printed answer book 4772
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Thursday 23 June 2011
Morning

Duration: 1 hour 30 minutes

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. 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

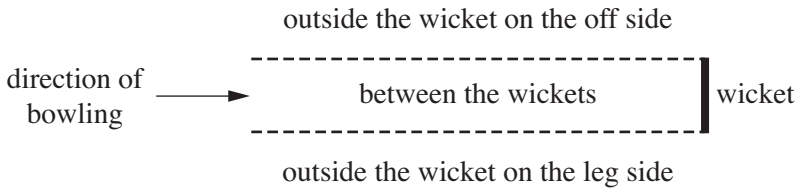
- Do not send this question paper for marking; it should be retained in the centre or destroyed.

1 **(a)** Heard in Parliament: "Will the minister not now discontinue her proposal to ban the protest?"

The minister replied "Yes I will."

To what had the minister committed herself logically, and why might that not have been her intention? **[4]**

(b) In a cricket tournament an umpire might be required to decide whether or not a batsman is out 'lbw', ie 'leg before wicket'. The lbw law for the tournament refers to parts of the cricket pitch as shown in the diagram (assuming a right-handed batsman):



The umpire has to make a number of judgements:

A Would the ball have hit the wicket?

B Did the ball hit the batsman, or part of his equipment other than the bat, without hitting the bat?

C Did the ball hit the batsman, or part of his equipment other than the bat, before hitting the bat?

D Was the part of the batsman or his equipment which was hit by the ball, between the wickets when it was hit?

E Was the part of the batsman or his equipment which was hit by the ball, outside of the wicket on the off side when it was hit?

F Was the batsman attempting to play a stroke?

The law can be interpreted as saying that the batsman is out lbw if $[(A \wedge B) \vee (A \wedge C)] \wedge [D \vee (E \wedge \sim F)]$.

The tournament's umpiring manual, in attempting to simplify the law, states that the batsman is out lbw if $A \wedge (B \vee C) \wedge (D \vee E) \wedge (D \vee \sim F)$.

For an lbw decision this requires 4 conditions each to be true.

(i) Use the rules of Boolean algebra to show that the manual's rule is logically equivalent to the law as stated above, naming the rules used at each step. **[7]**

A trainee umpire, using the manual, considers each condition in turn and judges that the following are true: A; B; E; D.

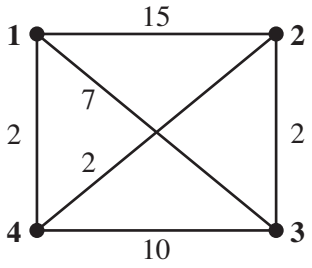
(ii) What is her decision and why? **[2]**

(iii) What is odd about her judgement, and does this make the logic invalid? **[3]**

2 A government has just created a new ministry, the Ministry of Administrative Affairs. The ministry is to have four departments:

the Administration
the Bureaucracy
the Certification Service
the Duplication Section.

Each of these departments is to be established in a separate office on one of four existing sites. The diagram shows the direct journey times in minutes between these four sites.



(i) Use Floyd's algorithm to find the shortest journey times between the four office sites. **[8]**

(ii) Draw a network showing your shortest times. **[1]**

(iii) Use appropriate algorithms to find upper and lower bounds for the optimum solution to the Travelling Salesperson Problem in the original network, briefly explaining the steps taken. **[4]**

(iv) A van is to be organised to deliver bundles of paperwork between the departments. Why might the optimum solution to the TSP be useful in planning this, and why might it not be? **[2]**

(v) Journeys to locations **2** and **3**, from locations **1** and **4**, are subject to a congestion charge which is equivalent in costing terms to 15 minutes of journey time. What sort of network would be needed to model this? **[1]**

3 Magnus has been researching career possibilities. He has just completed his GCSEs, and could leave school and get a good job. He estimates, discounted at today's values and given a 49 year working life, that there is a 50% chance of such a job giving him lifetime earnings of £1.5m, a 30% chance of £1.75m, and a 20% chance of £2m.

Alternatively Magnus can stay on at school and take A levels. He estimates that, if he does so, there is a 75% chance that he will achieve good results. If he does not achieve good results then he will still be able to take the same job as earlier, but he will have lost two years of his lifetime earnings. This will give a 50% chance of lifetime earnings of £1.42m, a 30% chance of £1.67m and a 20% chance of £1.92m.

If Magnus achieves good A level results then he could take a better job, which should give him discounted lifetime earnings of £1.6m with 50% probability or £2m with 50% probability. Alternatively he could go to university. This would cost Magnus another 3 years of lifetime earnings and would not guarantee him a well-paid career, since graduates sometimes choose to follow less well-paid vocations. His research shows him that graduates can expect discounted lifetime earnings of £1m with 20% probability, £1.5m with 30% probability, £2m with 30% probability, and £3m with 20% probability.

(i) Draw up a decision tree showing Magnus's options. **[7]**

(ii) Using the EMV criterion, find Magnus's best course of action, and give its value. **[7]**

Magnus has read that money isn't everything, and that one way to reflect this is to use a utility function and then compare expected utilities. He decides to investigate the outcome of using a function in which utility is defined to be the square root of value.

(iii) Using the expected utility criterion, find Magnus's best course of action, and give its utility. **[4]**

(iv) The possibility of high earnings (£3m) swings Magnus's decision towards a university education. Find what value instead of £3m would make him indifferent to choosing a university education under the EMV criterion. (Do not change the probabilities.) **[2]**

4 A small alpine hotel is planned. Permission has been obtained for no more than 60 beds, and these can be accommodated in rooms containing one, two or four beds.

The total floor areas needed are $15\,m^2$ for a one-bed room, $25\,m^2$ for a two-bed room and $40\,m^2$ for a four-bed room. The total floor area of the bedrooms must not exceed $700\,m^2$.

Marginal profit contributions per annum, in thousands of euros, are estimated to be 5 for a one-bed room, 9 for a two-bed room and 15 for a four-bed room.

(i) Formulate a linear programming problem to find the mix of rooms which will maximise the profit contribution within the two constraints. **[3]**

(ii) Use the simplex algorithm to solve the problem, and interpret your solution. **[8]**

It is decided that, for marketing reasons, at least 5 one-bed rooms must be provided.

(iii) Solve this modified problem using either the two-stage simplex method or the big-M method. You may wish to adapt your final tableau from part **(ii)** to produce an initial tableau, but you are not required to do so. **[5]**

(iv) The simplex solution to the revised problem is to provide 5 one-bed rooms, 15 two-bed rooms and 6.25 four-bed rooms, giving a profit contribution of €253 750. Interpret this solution in terms of the real world problem. **[1]**

(v) Compare the following solution to your answer to part **(iv)**: 8 one-bed rooms, 12 two-bed rooms and 7 four-bed rooms. Explain your findings. **[3]**

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OCR
RECOGNISING ACHIEVEMENT

ADVANCED GCE

MATHEMATICS (MEI)

4772

Decision Mathematics 2

PRINTED ANSWER BOOK

OCE/23481

Candidates answer on the printed answer book.

OCR supplied materials:
- Question paper 4772 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

Thursday 23 June 2011
Morning

Duration: 1 hour 30 minutes

4772

Candidate forename		Candidate surname	

Centre number						Candidate number				

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1(a)	
1(b)(i)	

1(b)(ii)	
1(b)(iii)	

2(i)

	1	2	3	4
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2(ii)

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2(v)	

3(i) & (ii)	

3(iii)	
3(iv)	

4(i)

4(ii)

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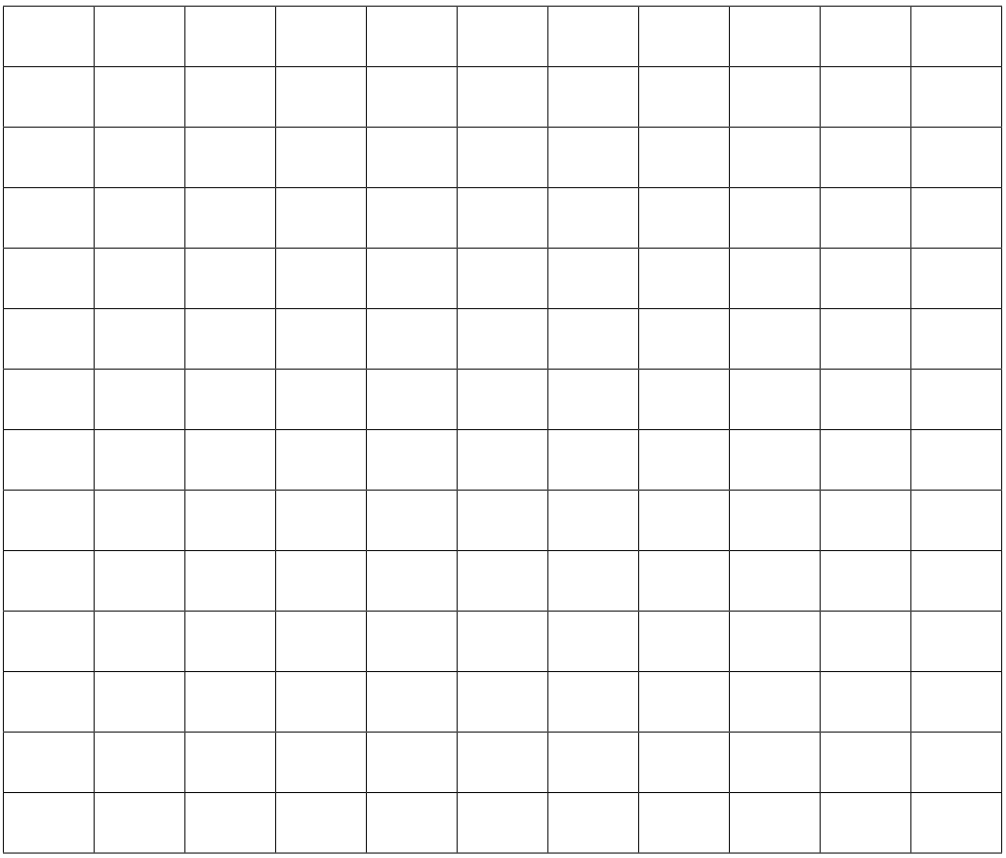
4(ii) **(continued)**

4(iii)



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4(iv)

4(v)

4(ii) & (iii)

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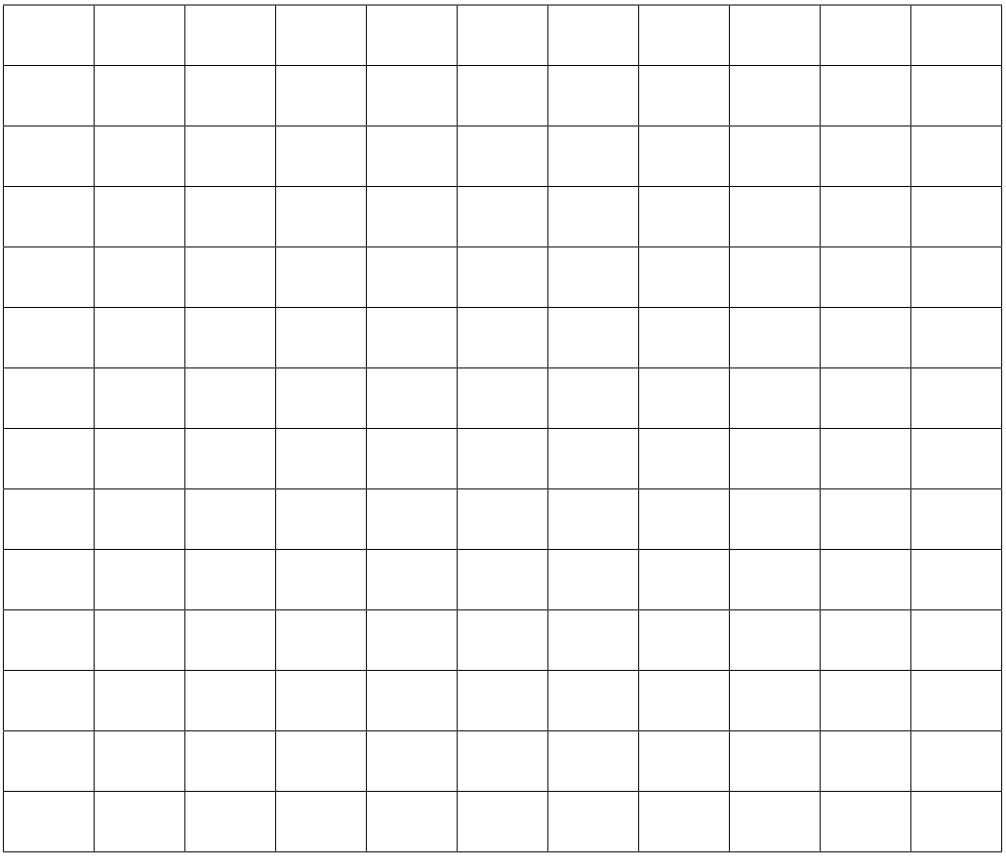

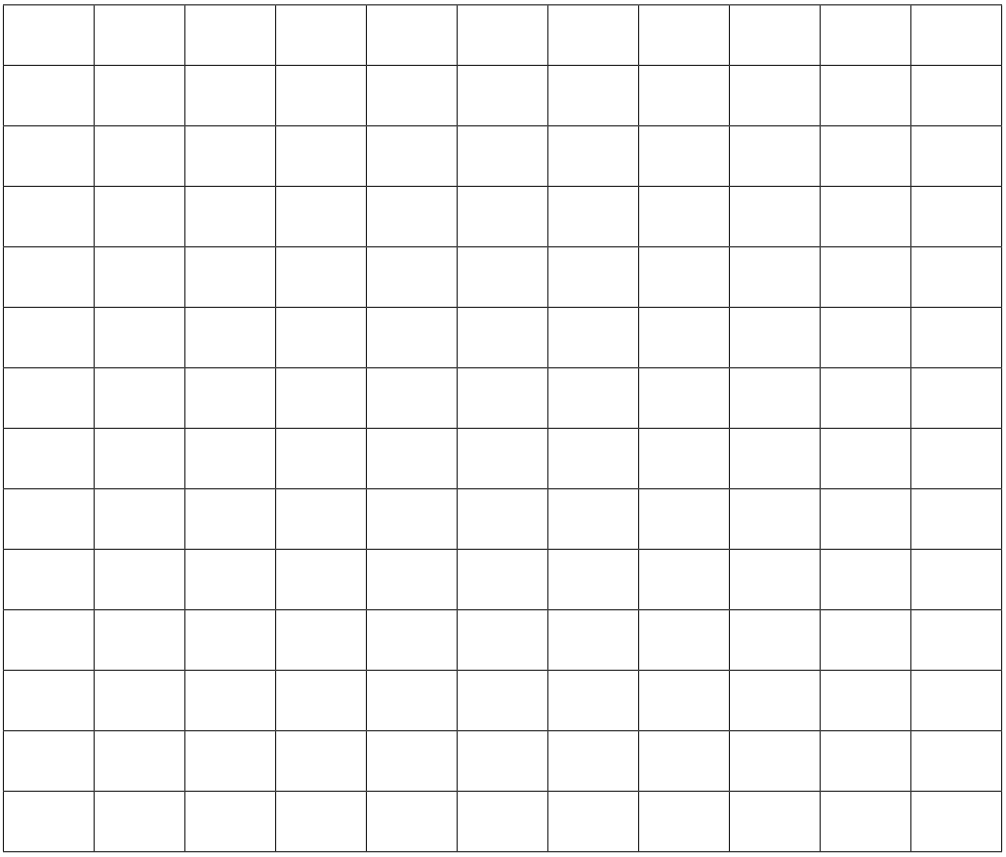

2(i)

SPARE COPY OF TABLES

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OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE

Unit **4772:** Decision Mathematics 2

Mark Scheme for June 2011

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

Subject-specific Marking Instructions for GCE Mathematics (MEI) Statistics 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. 3 significant figures may often be the norm for this, but this always needs to be considered in the context of the problem in hand. For example, in quoting probabilities from Normal tables, we generally expect *some* evidence of interpolation and so quotation to 4 decimal places will often be appropriate. But even this does not always apply – quotations of the standard critical points for significance tests such as 1.96, 1.645, 2.576 (maybe even 2.58 – but not 2.57) will commonly suffice, especially if the calculated value of a test statistic is nowhere near any of these values. Sensible discretion *must* be exercised in such cases.

Discretion must also be exercised in the case of small variations in the degree of accuracy to which an answer is given. For example, if 3 significant figures are expected (either because of an explicit instruction or because the general context of a problem demands it) but only 2 are given, loss of an accuracy ("A") mark is likely to be appropriate; but if 4 significant figures are given, this should not normally be penalised. Likewise, answers which are slightly deviant from what is expected in a very minor manner (for example a Normal probability given, after an attempt at interpolation, as 0.6418 whereas 0.6417 was expected) should not be penalised. However, answers which are *grossly* over- or under-specified should normally result in the loss of a mark. This includes cases such as, for example, insistence that the value of a test statistic is (say) 2.128888446667 merely because that is the value that happened to come off the candidate's calculator. Note that this applies to answers that are given as final stages of calculations; intermediate working should usually be carried out, and quoted, to a greater degree of accuracy to avoid the danger of premature approximation.

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 Genuine misreading (of numbers or symbols, occasionally even of text) occurs. If this results in the object and/or difficulty of the question being considerably changed, it is likely that all the marks for that question, or section of the question, will be lost. However, misreads are often such that the object and/or difficulty remain substantially unaltered; these cases are considered below.

The simple rule is that *all* method ("M") marks [and of course all independent ("B") marks] remain accessible but at least some accuracy ("A") marks do not. It is difficult to legislate in an overall sense beyond this global statement because misreads, even when the object and/or difficulty remains unchanged, can vary greatly in their effects. For example, a misread of 1.02 as 10.2 (perhaps as a quoted value of a sample mean) may well be catastrophic; whereas a misread of 1.6748 as 1.6746 may have so slight an effect as to be almost unnoticeable in the candidate's work.

A misread should normally attract *some* penalty, though this would often be only 1 mark and should rarely if ever be more than 2. Commonly in sections of questions where there is a numerical answer either at the end of the section or to be obtained and commented on (eg the value of a test statistic), this answer will have an "A" mark that may actually be designated as "cao" [correct answer only]. This should be interpreted *strictly* – if the misread has led to failure to obtain this value, then this "A" mark must be withheld even if all method marks have been earned. It will also often be the case that such a mark is implicitly "cao" even if not explicitly designated as such.

On the other hand, we commonly allow "fresh starts" within a question or part of question. For example, a follow-through of the candidate's value of a test statistic is generally allowed (and often explicitly stated as such within the marking scheme), so that the candidate may exhibit knowledge of how to compare it with a critical value and draw conclusions. Such "fresh starts" are not affected by any earlier misreads.

A misread may be of a symbol rather than a number – for example, an algebraic symbol in a mathematical expression. Such misreads are more likely to bring about a considerable change in the object and/or difficulty of the question; but, if they do not, they should be treated as far as possible in the same way as numerical misreads, *mutatis mutandis*. This also applied to misreads of text, which are fairly rare but can cause major problems in fair marking.

The situation regarding any particular cases that arise while you are marking for which you feel you need detailed guidance should be discussed with your Team Leader.

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

4772, June 2011, Markscheme

1.

(a) To not discontinue, i.e. to continue. "Will the minister not …" is a form of words in which the negation is not intended.	B1 B1 B1 B1	to continue double negation understanding ~~ language confusion	
(b)(i) $[(A\wedge B)\vee(A\wedge C)]\ \wedge[D\vee(E\wedge\sim F)]$ $\Leftrightarrow[(A\vee(A\wedge C))\wedge(B\vee(A\wedge C))]\wedge[(D\vee E)\wedge(D\vee\sim F)]$ $\Leftrightarrow(A\vee(A\wedge C))\wedge(B\vee(A\wedge C))\wedge[(D\vee E)\wedge(D\vee\sim F)]$ $\Leftrightarrow A\wedge[(B\vee A)\wedge(B\vee C)]\wedge(D\vee E)\wedge(D\vee\sim F)$ $\Leftrightarrow A\wedge(B\vee A)\wedge(B\vee C)\wedge(D\vee E)\wedge(D\vee\sim F)$ $\Leftrightarrow A\wedge(B\vee C)\wedge(D\vee E)\wedge(D\vee\sim F)$ or $A\wedge(B\vee C)\wedge(D\vee E)\wedge(D\vee\sim F)$ $\Leftrightarrow[A\wedge(B\vee C)]\wedge(D\vee E)\wedge(D\vee\sim F)$ $\Leftrightarrow[A\wedge(B\vee C)]\wedge[(D\vee E)\wedge(D\vee\sim F)]$ $\Leftrightarrow[(A\wedge B)\vee(A\wedge C)]\wedge[(D\vee E)\wedge(D\vee\sim F)]$ $\Leftrightarrow[(A\wedge B)\vee(A\wedge C)]\wedge[D\vee(E\wedge\sim F)]$	M1 A1 A1 M1 A1 A1 B1 M1 A1 A1 M1 A1 A1 B1	uses distributive rule distributive rule "distributive rule" uses associative rule associative rule "associative rule" rest correct uses distributive rule distributive rule "distributive rule" uses associative rule associative rule "associative rule" rest correct	 ft ft SC if refers to "absorption" then +1 ft ft
(ii) Out, LBW! Either first square bracket and second square bracket, or all 4 conditions are satisfied	B1 B1	"out" using either test	
(iii) Can't have D and E both true at the same time. Logic still valid. Logic not concerned with consistency of input, only whether out or not.	B1 B1 B1		

2.

(i)

	1	2	3	4
1	∞	15	7	2
2	15	∞	2	2
3	7	2	∞	10
4	2	2	10	∞

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

B1 time matrix
B1 route matrix

	1	2	3	4
1	∞	15	7	2
2	15	30	2	2
3	7	2	14	9
4	2	2	9	4

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

M1 replacing an ∞ by a correct value
A1

	1	2	3	4
1	30	15	7	2
2	15	30	2	2
3	7	2	4	4
4	2	2	4	4

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

A1 ft

	1	2	3	4
1	14	9	7	2
2	9	4	2	2
3	7	2	4	4
4	2	2	4	4

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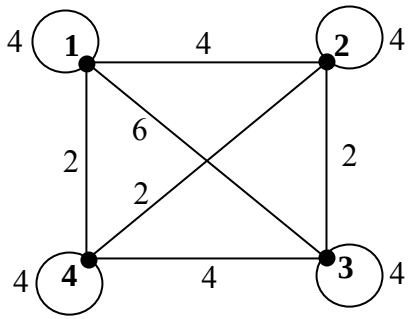
3	1	2	2	2
4	1	2	2	1

A1 ft

	1	2	3	4
1	4	4	6	2
2	4	4	2	2
3	6	2	4	4
4	2	2	4	4

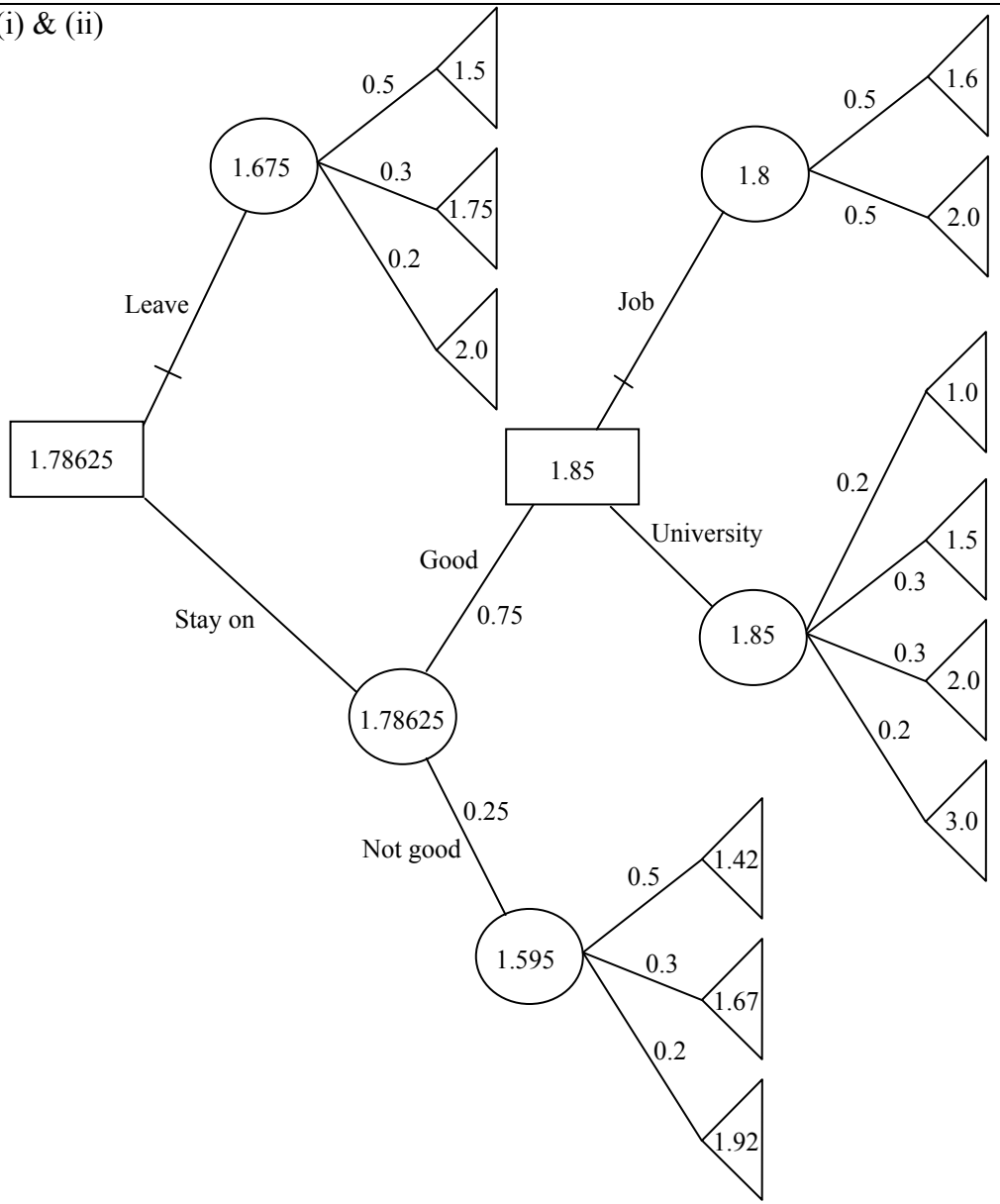
	1	2	3	4
1	4	4	4	4
2	4	3	3	4
3	2	2	2	2
4	1	2	2	1

A1 entries other than row 3 col 1 of route matrix ... ft
B1 row 3 col 1 of route matrix ... cao

(ii)		B1	ft	
(iii)	Upper – nearest neighbour – e.g. 2+2+2+6 = 12	M1	nearest neighbour	mention of nearest neighbour or a nearest neighbour computation
		A1		allow 2+2+2+7=13 etc for working in original network
	Lower – e.g. "delete" **1**, and compute (2+2)+2+4 = 10	M1	delete a vertex	
		A1	rest of computation	needs to be consistent with above
(iv)	e.g. if the requirement is for part loads, and deliver to one department en route to another, then might save time.	B1		answer should be valid and refer to the specific situation of the DAA
	e.g. if the requirement is for part whole loads then might not be relevant.	B1		
(v)	A directed network.	B1		

3.

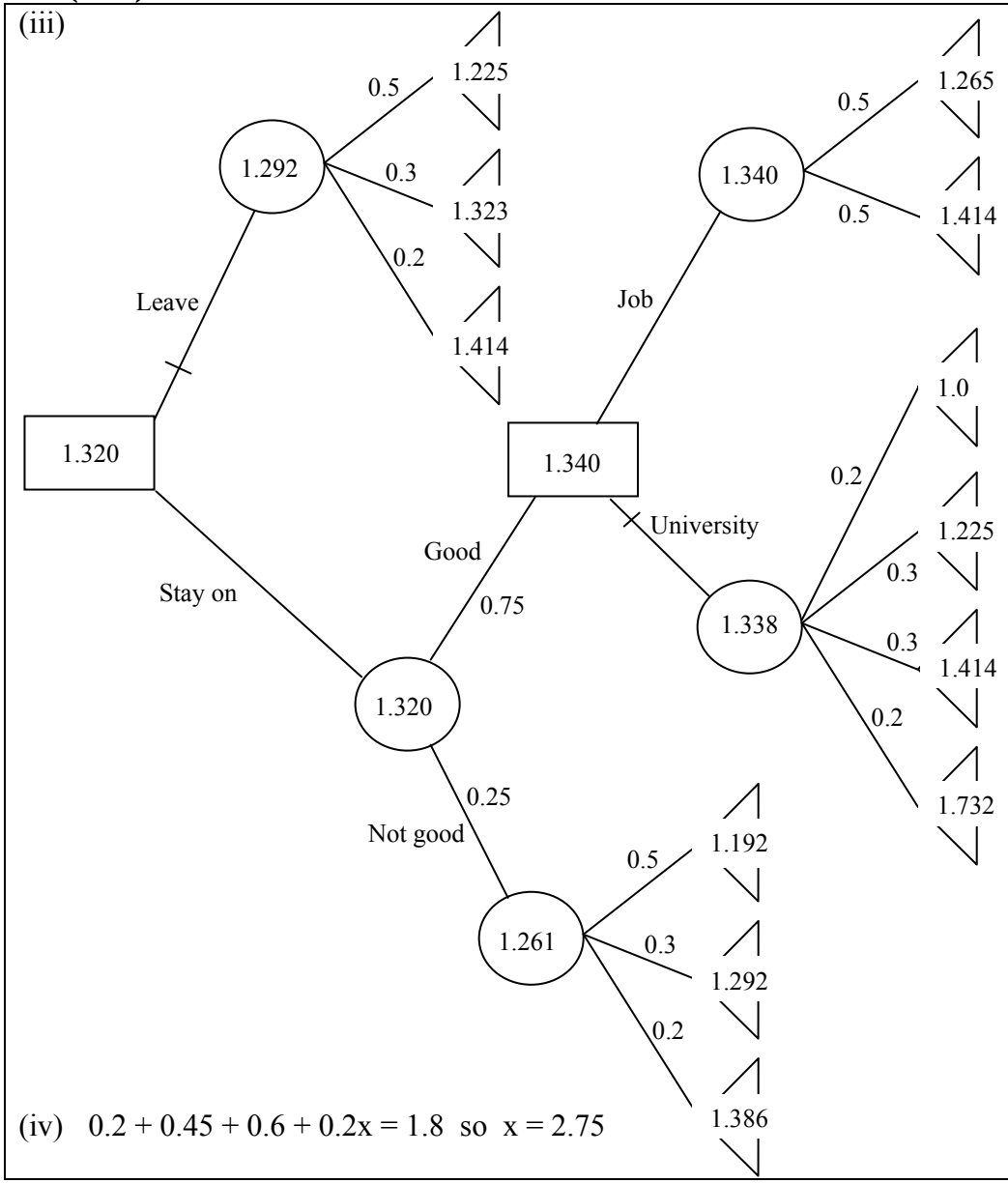
(i) & (ii)



B1	stay on/leave	decision node
B1	leave	chance node with 3 branches
B1	good A/not good	chance node
B1	not good	chance node with 3 branches
B1	job/uni	decision node
B1	job	chance node with 2 branches
B1	uni	chance node with 4 branches
B1	leave computation	cao
B1	job computation	cao
B1	uni computation	cao
B1	good comp	ft
B1	not good comp	cao
B1	good/not good	ft
B1	stay on for 1.78625	cao

3 (cont)

(iii)



M1 utilities of outcomes
A1 cao

M1 computing backwards
A1 ft

(iv) $0.2 + 0.45 + 0.6 + 0.2x = 1.8$ so $x = 2.75$

M1 A1 cao

equation with 0.2 x or division by 0.2

4.

(i) Definition of variables	B1	needs to say "number of"
Max $5x + 9y + 15z$	B1 objective	
st $x + 2y + 4z \leq 60$		
$15x + 25y + 40z \leq 700$	B1 constraints	
(ii)		

P	x	y	z	s1	s2	RHS
1	–5	–9	–15	0	0	0
0	1	2	4	1	0	60
0	15	25	40	0	1	700
1	–5/4	–3/2	0	15/4	0	225
0	1/4	1/2	1	1/4	0	15
0	5	5	0	–10	1	100
1	1/4	0	0	3/4	3/10	255
0	–1/4	0	1	5/4	–1/10	5
0	–1	1	0	–2	1/5	20

	M1 initial tableau	two slack variables
	A1 ft	
	M1 first iteration	identifying correct pivot
	A1 ft	
	M1 second iteration	identifying correct pivot
	A1 ft	
Identification of basic variables (y and z)	B1 ft	
+ values (inc objective)	B1 ft	

(iii)

A	P	x	y	z	s1	s2	s3	a	RHS
1	0	1	0	0	0	0	–1	0	5
0	1	1/4	0	0	3/4	3/10	0	0	255
0	0	–1/4	0	1	5/4	–1/10	0	0	5
0	0	1	1	0	–2	1/5	0	0	20
0	0	1	0	0	0	0	–1	1	5
1	0	0	0	0	0	0	0	–1	0
0	1	0	0	0	3/4	3/10	1/4	–1/4	253.75
0	0	0	0	1	5/4	–1/10	–1/4	1/4	6.25
0	0	0	1	0	–2	1/5	1	–1	15
0	0	1	0	0	0	0	–1	1	5

B1 ≥ row
B1 new objective

M1 pivot
A1 objectives cao
A1 constraints cao for basic variables

If from scratch, then M1 for first pivot, A1 for final objective row(s) and A1 for final constraint rows.

or

P	x	y	z	s1	s2	s3	RHS
1	–M+1/4	0	0	3/4	3/10	M	255–5M
0	–1/4	0	1	5/4	–1/10	0	5
0	1	1	0	–2	1/5	0	20
0	1	0	0	0	0	–1	5
1	0	0	0	3/4	3/10	1/4	253.75
0	0	0	1	5/4	–1/10	–1/4	6.25
0	0	1	0	–2	1/5	1	15
0	1	0	0	0	0	–1	5

or (same scheme)

B1 ≥ row
B1 new objective

M1 pivot
A1 objective cao
A1 constraints cao for basic variables

(iv) 5, 15 and 6 at £250000

B1

(v) 8, 12 and 7 is feasible and gives £253000
IP solution need not be "near" to LP solution

B1 B1
B1

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4772: Decision Mathematics 2

General Comments

Candidates found parts of this paper very much to their liking, for instance the decision analysis in question 3. They had been well prepared and had learned well, and all are to be congratulated for that.

Comments on Individual Questions

1 **Logic**

(a) Most candidates understood the issue, although the negativity of "ban the protest" created confusion for some. They analysed that a triple negative was involved.

(b) Prior knowledge of the cricket context was of no advantage.

The Boolean algebra was tackled well. Note that the first part of the published solution takes the longer route, opening brackets, to demonstrate how that works. Most candidates, very acceptably, took the much shorter route of factorisation. Marks were mostly lost in appending the correct name to the rule being used.

The last section of the question was more challenging. Candidates gave the batsman out in part (iii), spotted the issue in part (iv) and agreed that the logic was still valid, but did not really get to the nub of the issue in their analysis.

2 **Networks**

(i)(ii) It is not usual for a complete application of Floyd to be set – usually just one or two iterations are tested. Naturally, the network must be small for this.

The questions worked well, and most candidates scored well.

(iii) The unit is very careful to draw the distinction between the practical "TSP" problem and the classical "minimum Hamiltonian in a complete network" problem. The real life travelling salesman doesn't care too much about where his best route takes him, revisiting, retracing etc.

These two problems are reconciled by working in the complete network of shortest distances which is constructed from the original network. So candidates were expected, in part (iii), to be working in the network which they had just drawn in part (ii). However, it is impossible not to refer here to the "TSP problem defined in the original network", and understandable that some candidates were confused by this.

The mark scheme on this occasion allowed candidates to work in either network, but not both. Indeed several candidates seemed unperturbed when they produced a lower bound of 13 by working in the original network, and an upper bound of 12 by working in the complete network of shortest distances.

(iv) Interpretation is part of modelling, and modelling is difficult. Many candidates failed to realise that this question was related to modelling, and that their comments needed to be related to the physical situation and not too fanciful, i.e. not too far removed from the question.

(v) Easy to mark ... a digraph ... right or wrong. Some candidates scored the point.

3 **Decision Analysis**

There is not much to say about this question, other than "Well done!" Candidates sorted out the complex situation, carefully attended to the distinction between decision nodes and chance nodes, and knew that utility is not linear, i.e. that $p \times \text{utility}(a) + q \times \text{utility}(b) \neq \text{utility}(p \times a + q \times b)$.
Part (iv) was also very well answered.

4 **Linear Programming (Simplex)**

(i) Most succeeded with the formulation. Note that examiners were required to be very particular in requiring definitions to refer to "the number of", since one of the root causes of difficulties in algebraic understanding is a failure to realise that letters stand for numbers, and not objects.

(ii) The basic simplex algorithm was well understood and executed by most candidates. Candidates who made slips often ended up with only one of x, y and z being non-zero. Whilst this is possible in exceptional cases (it would correspond to the best vertex of the feasible polyhedron lying on an axis), it should have been a warning that something might well have gone wrong.

(iii) This was challenging, and was quite often very well done. Some candidates successfully used the solution to (ii) in their formulation, and had an easier job in their manipulation, others formulated more easily ab initio, but had more manipulation.

(iv) Candidates were expected to produce the integer solution (5 15 6) and to compute the number of rooms there. Some missed the point.

(v) Candidates were expected to note that this integer solution is better, but is not revealed by Simplex. Not all noted this.

GCE Mathematics (MEI)

			Max Mark	a	b	c	d	e	u
4751/01	(C1) MEI Introduction to Advanced Mathematics	Raw	72	55	49	43	37	32	0
		UMS	100	80	70	60	50	40	0
4752/01	(C2) MEI Concepts for Advanced Mathematics	Raw	72	53	46	39	33	27	0
		UMS	100	80	70	60	50	40	0
4753/01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	54	48	42	36	29	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	63	56	50	44	38	0
		UMS	100	80	70	60	50	40	0
4755/01	(FP1) MEI Further Concepts for Advanced Mathematics	Raw	72	59	52	45	39	33	0
		UMS	100	80	70	60	50	40	0
4756/01	(FP2) MEI Further Methods for Advanced Mathematics	Raw	72	55	48	41	34	27	0
		UMS	100	80	70	60	50	40	0
4757/01	(FP3) MEI Further Applications of Advanced Mathematics	Raw	72	55	48	42	36	30	0
		UMS	100	80	70	60	50	40	0
4758/01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	57	51	45	39	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	60	52	44	36	28	0
		UMS	100	80	70	60	50	40	0
4762/01	(M2) MEI Mechanics 2	Raw	72	64	57	51	45	39	0
		UMS	100	80	70	60	50	40	0
4763/01	(M3) MEI Mechanics 3	Raw	72	59	51	43	35	27	0
		UMS	100	80	70	60	50	40	0
4764/01	(M4) MEI Mechanics 4	Raw	72	54	47	40	33	26	0
		UMS	100	80	70	60	50	40	0
4766/01	(S1) MEI Statistics 1	Raw	72	53	45	38	31	24	0
		UMS	100	80	70	60	50	40	0
4767/01	(S2) MEI Statistics 2	Raw	72	60	53	46	39	33	0
		UMS	100	80	70	60	50	40	0
4768/01	(S3) MEI Statistics 3	Raw	72	56	49	42	35	28	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	51	45	39	33	27	0
		UMS	100	80	70	60	50	40	0
4772/01	(D2) MEI Decision Mathematics 2	Raw	72	58	53	48	43	39	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	62	55	49	43	36	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