Friday 21 June 2013 – Morning

A2 GCE MATHEMATICS (MEI)

4772/01 Decision Mathematics 2

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4772/01
- MEI Examination Formulae and Tables (MF2)

Other materials required:
- Scientific or graphical calculator

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. 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.

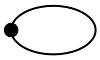
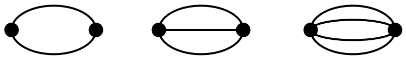
INFORMATION FOR CANDIDATES

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.

1 **(a)** A graph is simple if it contains neither loops nor multiple arcs, ie none of the following:  or  …

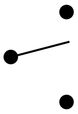
In an examination question, students were asked to describe in words when a graph is simple. Mark the following responses as right or wrong, giving reasons for your decisions if you mark them wrong.

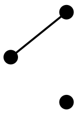
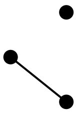
(i) A graph is simple if there are no loops and if two nodes are connected by a single arc.

(ii) A graph is simple if there are no loops and no two nodes are connected by more than one arc.

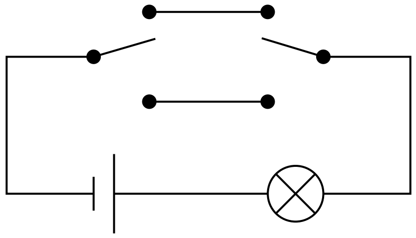
(iii) A graph is simple if there are no loops and two arcs do not have the same ends.

(iv) A graph is simple if there are no loops and there is at most one route from one node to another. **[7]**

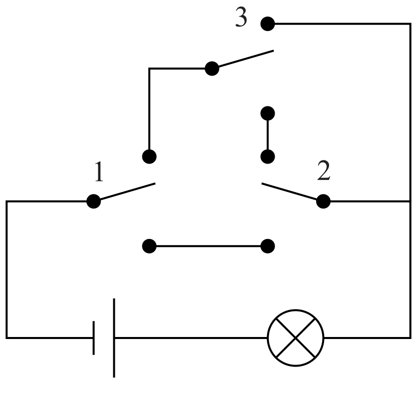
(b) The following picture represents a two-way switch  .

It can either be in the up state  or in the down state  .

Two switches can be used to construct a circuit in which changing the state of either switch changes the state of a lamp.



Georgios tries to connect together three two-way switches so that changing the state of any switch changes the state of the lamp. His circuit is shown below. The switches have been labelled 1, 2 and 3.



(i) List the possible combination of switch states and determine whether the lamp is on or off for each of them.

(ii) Say whether or not Georgios has achieved his objective, justifying your answer. **[5]**

(c) Use a truth table to show that $(A \wedge (B \vee C)) \vee \sim(\sim A \vee (B \wedge C)) \Leftrightarrow A$. **[4]**

2 Graham skis each year in an Italian resort which shares a ski area with a Swiss resort. He can buy an Italian lift pass, or an international lift pass which gives him access to Switzerland as well as to Italy. For his 6-day holiday the Italian pass costs €200 and the international pass costs €250. If he buys an Italian pass then he can still visit Switzerland by purchasing day supplements at €30 per day.

If the weather is good during his holiday, then Graham visits Switzerland three times. If the weather is moderate he goes twice. If poor he goes once. If the weather is windy then the lifts are closed, and he is not able to go at all.

In his years of skiing at the resort he has had good weather on 30% of his visits, moderate weather on 40%, poor weather on 20% and windy weather on 10% of his visits.

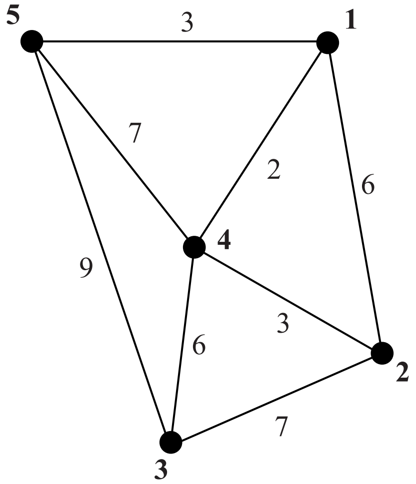
(i) Draw a decision tree to help Graham decide whether to buy an Italian lift pass or an international lift pass. Give the action he should take to minimize the EMV of his costs. **[6]**

When he arrives at the resort, and before he buys his lift pass, he finds that he has internet access to a local weather forecast, and to records of the past performance of the forecast. The 6-day forecast is limited to "good"/"not good", and the records show the actual weather proportions following those forecasts. It also shows that 60% of historical forecasts have been "good" and 40% "not good".

Actual / Forecast	good	moderate	poor	windy	proportion of forecasts
good	0.4	0.5	0.1	0.0	0.6
not good	0.15	0.25	0.35	0.25	0.4

(ii) Draw a decision tree to help Graham decide the worth of consulting the forecast before buying his lift pass. Give the actions he should take to minimize the EMV of his costs. **[10]**

3 Five towns, **1**, **2**, **3**, **4** and **5**, are connected by direct routes as shown. The arc weights represent distances.



(i) The printed answer book shows the initial tables and the results of iterations 1, 2, 3 and 5 when Floyd's algorithm is applied to the network.

(*A*) Complete the two tables for iteration 4. **[6]**

(*B*) Use the final route table to give the shortest route from vertex **5** to vertex **2**. **[1]**

(*C*) Use the final distance table to produce a complete network with weights representing the shortest distances between vertices. **[2]**

(ii) Use the nearest neighbour algorithm, starting at vertex **4**, to produce a Hamilton cycle in the complete network. Give the length of your cycle. **[3]**

(iii) Interpret your Hamilton cycle from part **(ii)** in terms of towns actually visited. **[1]**

(iv) Find an improved Hamilton cycle by applying the nearest neighbour algorithm starting from one of the other vertices. **[1]**

(v) Using the complete network of shortest distances (excluding loops), find a lower bound for the solution to the Travelling Salesperson Problem by deleting vertex **4** and its arcs, and by finding the length of a minimum connector for the remainder. (You may find the minimum connector by inspection.) **[3]**

(vi) Given that the sum of the road lengths in the original network is 43, give a walk of minimum length which traverses every arc on the original network at least once, and which returns to the start. Show your methodology. Give the length of your walk. **[3]**

4 Colin has a hobby from which he makes a small income. He makes bowls, candle holders and key fobs.

The materials he uses include wood, metal parts, polish and sandpaper. They cost, on average, £15 per bowl, £6 per candle holder and £2 per key fob. Colin has a monthly budget of £100 for materials.

Colin spends no more than 30 hours per month on manufacturing these objects. Each bowl takes 4 hours, each candle holder takes 2 hours and each key fob takes half an hour.

(i) Let b be the number of bowls Colin makes in a month, c the number of candle holders and f the number of key fobs. Write out, in terms of these variables, two constraints corresponding to the limit on monthly expenditure on materials, and to the limit on Colin's time. **[2]**

Colin sells the objects at craft fairs. He charges £30 for a bowl, £15 for a candle holder and £3 for a key fob.

(ii) Set up an initial simplex tableau for the problem of maximising Colin's monthly income subject to your constraints from part **(i)**, assuming that he sells all that he produces. **[2]**

(iii) Use the simplex algorithm to solve your LP, and interpret the solution from the simplex algorithm. **[8]**

Over a spell of several months Colin finds it difficult to sell bowls so he stops making them.

(iv) Modify and solve your LP, using simplex, to find how many candle holders and how many key fobs he should make, and interpret your solution. **[3]**

At the next craft fair Colin takes an order for 4 bowls. He promises to make exactly 4 bowls in the next month.

(v) Set up this modified problem either as an application of two-stage simplex, or as an application of the big-M method. You are not required to solve the problem. **[3]**

The solution now is for Colin to produce 4 bowls, $6\frac{2}{3}$ candle holders and no key fobs.

(vi) What is Colin's best integer solution to the problem? **[1]**

(vii) Your answer to part **(vi)** is not necessarily the integer solution giving the maximum profit for Colin. Explain why. **[1]**

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Friday 21 June 2013 – Morning

A2 GCE MATHEMATICS (MEI)

4772/01 Decision Mathematics 2

PRINTED ANSWER BOOK

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- Question Paper 4772/01 (inserted)
- MEI Examination Formulae and Tables (MF2)

Other materials required:
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Duration: 1 hour 30 minutes

Candidate forename		Candidate surname	

Centre number						Candidate number				

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Turn over

1 (a) (i)

1 (a) (ii)

1 (a) (iii)

1 (a) (iv)

1 (b) (i)

1 (b) (ii)

1 (c)

2 (i)

2 (ii)

3

	1	**2**	**3**	**4**	**5**
1	∞	6	∞	2	3
2	6	∞	7	3	∞
3	∞	7	∞	6	9
4	2	3	6	∞	7
5	3	∞	9	7	∞

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

	1	**2**	**3**	**4**	**5**
1	∞	6	∞	2	3
2	6	12	7	3	9
3	∞	7	∞	6	9
4	2	3	6	4	5
5	3	9	9	5	6

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

	1	**2**	**3**	**4**	**5**
1	12	6	13	2	3
2	6	12	7	3	9
3	13	7	14	6	9
4	2	3	6	4	5
5	3	9	9	4	6

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

	1	**2**	**3**	**4**	**5**
1	12	6	13	2	3
2	6	12	7	3	9
3	13	7	14	6	9
4	2	3	6	4	5
5	3	9	9	5	6

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

3 (i) (*A*)

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

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

	1	**2**	**3**	**4**	**5**
1	4	5	8	2	3
2	5	6	7	3	8
3	8	7	12	6	9
4	2	3	6	4	5
5	3	8	9	5	6

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

3 (i) (*B*)

3 (i) (*C*)

3 (ii)

3 (iii)

3 (iv)

Turn over

3 (v)

3 (vi)

4 (i)	
4 (ii)	
4 (iii)	

Turn over

4 (iv)

4 (v)

4 (vi)

4 (vii)

PLEASE DO NOT WRITE ON THIS PAGE

GCE

Mathematics (MEI)

Advanced GCE

Unit **4772:** Decision Mathematics 2

Mark Scheme for June 2013

Oxford Cambridge and RSA Examinations

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of candidates of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, Cambridge Nationals, Cambridge Technicals, 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.

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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

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.

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1
1
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1</td><td>(a)
(a)
(a)
(a)</td><td>(i)
(ii)
(iii)
(iv)</td><td>Wrong ... only refers to one pair of nodes
Right
Wrong ... only refers to one pair of arcs
Wrong ... arguably general in reference to nodes, but refers to route rather than arc</td><td>B1
B1
B1
B1
B1
B1
B1
[7]</td><td></td></tr>
<tr><td>1</td><td>(b)</td><td>(i)</td><td>
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</td><td>M1
A3</td><td>8 combinations
–1 each error</td></tr>
<tr><td>1</td><td>(b)</td><td>(ii)</td><td>No. e.g. if 1 and 2 both up, then 3 has no effect.</td><td>B1
[5]</td><td>Needs valid counter-example</td></tr>
<tr><td>1</td><td>(c)</td><td></td><td>
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<tr><td>(A</td><td>∧</td><td>(B</td><td>∨</td><td>C))</td><td>∨</td><td>~</td><td>(~</td><td>A</td><td>∨</td><td>(B</td><td>∧</td><td>C))</td></tr>
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A3
[4]</td><td>8 rows
–1 each error</td></tr>
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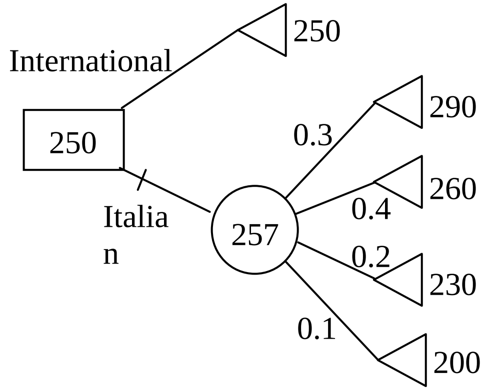
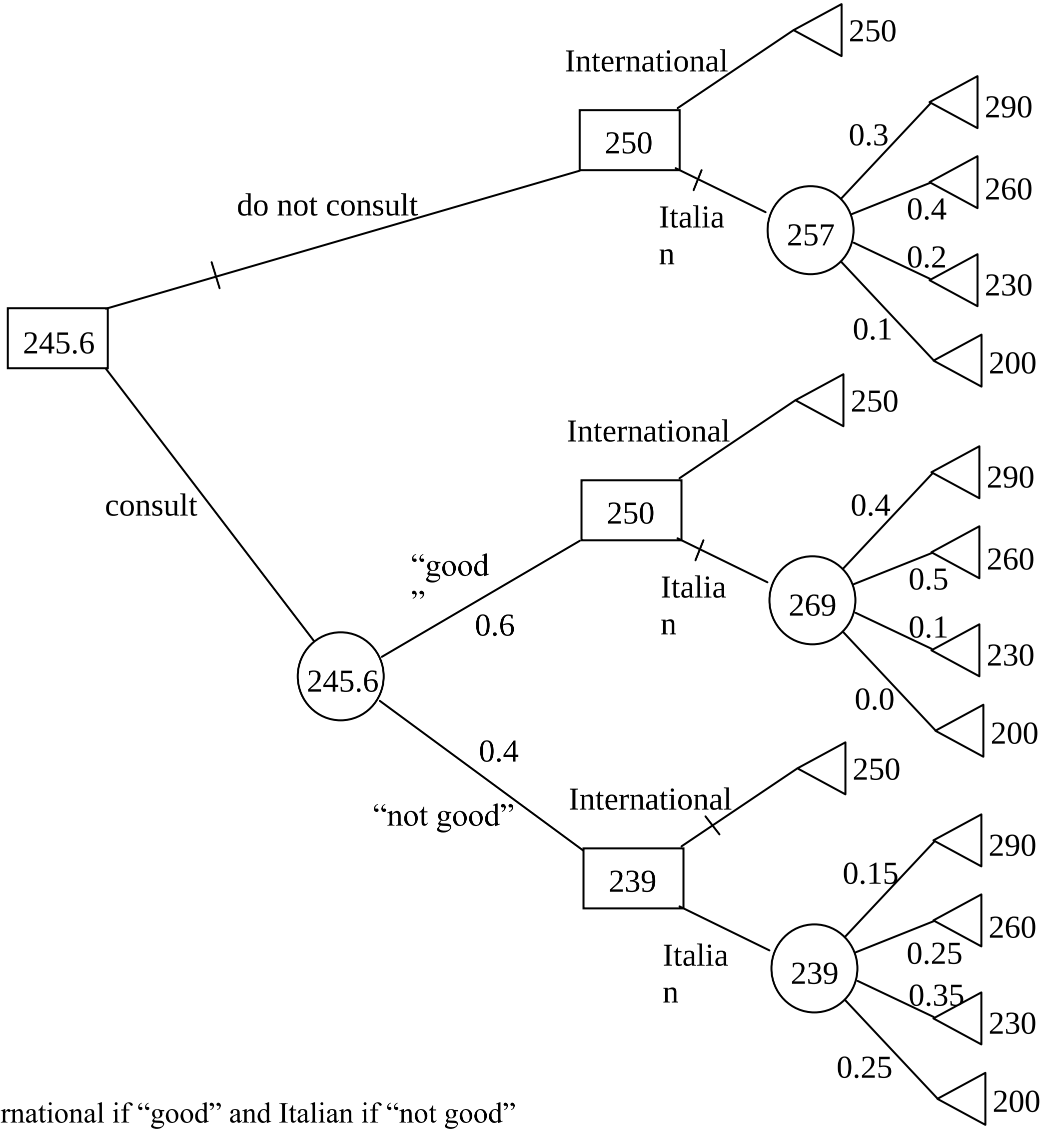
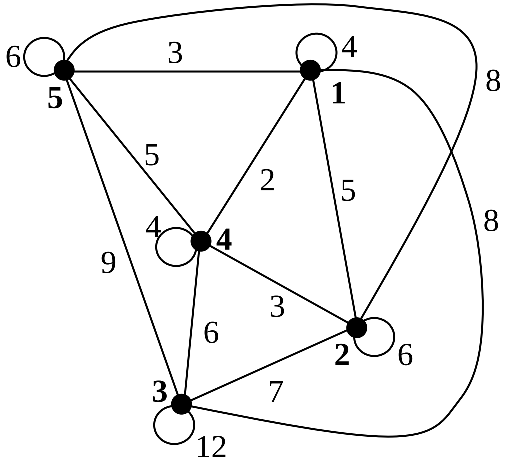
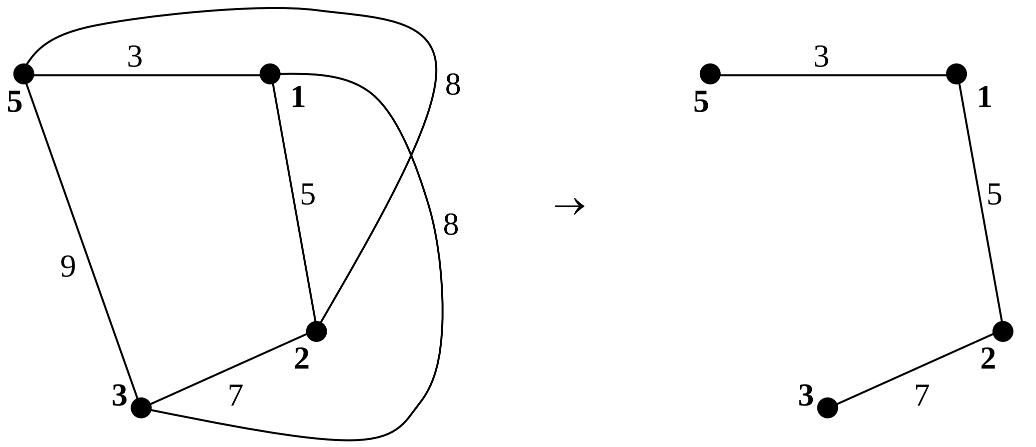
Question			Answer	Marks	Guidance
2	**(i)**			B1 M1 A1 M1 A1	decision node chance node 4 possibilities costs (90, 60, 30, 0 OK) cao 257
			Buy international and pass.	B1 **[6]**	

Question			Answer	Marks	Guidance
2	(ii)			B1	new decision node
				B1	"do not consult" branch
				B1	"consult" chance node
				B1	EMV at chance node cao
				B1	EMV at "good" decision node cao
				B1	269 at chance node cao
				B1	EMV "not good" decision node cao
				B1	239 at chance node cao
			Consult	B1	
			Buy international if "good" and Italian if "not good"	B1	
				[10]	

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>3</td><td>(i)</td><td>(A)</td><td>
<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr>
<tr><td>1</td><td>4</td><td>5</td><td>8</td><td>2</td><td>3</td></tr>
<tr><td>2</td><td>5</td><td>6</td><td>7</td><td>3</td><td>8</td></tr>
<tr><td>3</td><td>8</td><td>7</td><td>12</td><td>6</td><td>9</td></tr>
<tr><td>4</td><td>2</td><td>3</td><td>6</td><td>4</td><td>5</td></tr>
<tr><td>5</td><td>3</td><td>8</td><td>9</td><td>5</td><td>6</td></tr>
</table>
<table>
<tr><th></th><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th></tr>
<tr><td>1</td><td>4</td><td>4</td><td>4</td><td>4</td><td>5</td></tr>
<tr><td>2</td><td>4</td><td>4</td><td>3</td><td>4</td><td>4</td></tr>
<tr><td>3</td><td>4</td><td>2</td><td>4</td><td>4</td><td>5</td></tr>
<tr><td>4</td><td>1</td><td>2</td><td>3</td><td>1</td><td>1</td></tr>
<tr><td>5</td><td>1</td><td>1</td><td>3</td><td>1</td><td>1</td></tr>
</table>
</td><td>M1
A2
M1
A2
[6]</td><td>distances 1→1 and 1→2
rest OK
route 5→2
rest OK</td></tr>
<tr><td>3</td><td>(i)</td><td>(B)</td><td>5 → 1 → 4 → 2</td><td>B1
[1]</td><td>cao</td></tr>
<tr><td>3</td><td>(i)</td><td>(C)</td><td>
</td><td>M1
A1
[2]</td><td>complete, inc loops
cao</td></tr>
<tr><td>3</td><td>(ii)</td><td></td><td>4 → (2) → 1 → (3) → 5 → (8) → 2 → (7) → 3 → (6) → 4
Length = 26</td><td>M1
A1
B1
[3]</td><td>4 → 1 → 5
complete, inc return to 4
cao</td></tr>
<tr><td>3</td><td>(iii)</td><td></td><td>4 → 1 → 5 → (1 → 4) → 2 → 3 → 4</td><td>B1
[1]</td><td></td></tr>
<tr><td>3</td><td>(iv)</td><td></td><td>Starting at 1, 2 or 5 gives an HC of length 24.</td><td>B1
[1]</td><td></td></tr>
</table>

Question			**Answer**	**Marks**	**Guidance**
3	**(v)**			M1 A1	3-arc connector 15
			lower bound = 15 + 2 + 3 = 20	B1 **[3]**	+ 2 + 3
3	**(vi)**		odd vertices are **1**, **2**, **3**, **5**		
			Pairings (**1**,**2**) and (**3**,**5**) ... 5+9 = 14 (**1**,**3**) and (**2**,**5**) ... 8+8 = 16 (**1**,**5**) and (**2**,**3**) ... 3+7 = 10	M1	must have indication of pairing odd vertices
			So min length = 43 + 3 + 7 = 53	A1	cao
			eg. route ... **1 5 1 2 3 2 4 3 5 4 1**	B1 **[3]**	cao

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>(i)</td><td></td><td>materials $15b + 6c + 2f \le 100$
time $4b + 2c + \frac{1}{2}f \le 30$</td><td>B1
B1
[2]</td><td>cao
cao</td></tr>
<tr><td>4</td><td>(ii)</td><td></td><td>
<table>
<tr><th>I</th><th>b</th><th>c</th><th>f</th><th>s1</th><th>s2</th><th>RHS</th></tr>
<tr><td>1</td><td>–30</td><td>–15</td><td>–3</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>15</td><td>6</td><td>2</td><td>1</td><td>0</td><td>100</td></tr>
<tr><td>0</td><td>4</td><td>2</td><td>$\frac{1}{2}$</td><td>0</td><td>1</td><td>30</td></tr>
</table>
</td><td>B1
B1
[2]</td><td>objective ... cao
rest ... cao</td></tr>
<tr><td>4</td><td>(iii)</td><td></td><td>
<table>
<tr><td>1</td><td>0</td><td>–3</td><td>1</td><td>2</td><td>0</td><td>200</td></tr>
<tr><td>0</td><td>1</td><td>$\frac{2}{5}$</td><td>$\frac{2}{15}$</td><td>$\frac{1}{15}$</td><td>0</td><td>$\frac{20}{3}$</td></tr>
<tr><td>0</td><td>0</td><td>$\frac{2}{5}$</td><td>$-\frac{1}{30}$</td><td>$-\frac{4}{15}$</td><td>1</td><td>$\frac{10}{3}$</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>$\frac{3}{4}$</td><td>0</td><td>$\frac{15}{2}$</td><td>225</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>$\frac{1}{6}$</td><td>$\frac{1}{3}$</td><td>–1</td><td>$\frac{10}{3}$</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>$-\frac{1}{12}$</td><td>$-\frac{2}{3}$</td><td>$\frac{5}{2}$</td><td>$\frac{25}{3}$</td></tr>
</table>
Non-integer solution ($3\frac{1}{3}$ bowls and $8\frac{1}{3}$ candle holders) using all of budget and all available time, giving income of £225
</td><td>B1
M1
A1
B1
M1
A1
B1
B1
[8]</td><td>pivot
first iteration
cao
pivot
second iteration
cao
solution ft
resources and income cao</td></tr>
<tr><td>4</td><td>(iv)</td><td></td><td>e.g.
<table>
<tr><th>I</th><th>b</th><th>c</th><th>f</th><th>s1</th><th>s2</th><th>RHS</th></tr>
<tr><td>1</td><td>0</td><td>–15</td><td>–3</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>15</td><td>6</td><td>2</td><td>1</td><td>0</td><td>100</td></tr>
<tr><td>0</td><td>4</td><td>2</td><td>$\frac{1}{2}$</td><td>0</td><td>1</td><td>30</td></tr>
<tr><td>1</td><td>30</td><td>0</td><td>$\frac{3}{4}$</td><td>0</td><td>$\frac{15}{2}$</td><td>225</td></tr>
<tr><td>0</td><td>3</td><td>0</td><td>$\frac{1}{2}$</td><td>1</td><td>–3</td><td>10</td></tr>
<tr><td>0</td><td>2</td><td>1</td><td>$\frac{1}{4}$</td><td>0</td><td>$\frac{1}{2}$</td><td>15</td></tr>
</table>
Make 15 candleholders. Same income as before, but £10 materials remain (and integer solution this time).
</td><td>M1
A1
A1
[3]</td><td>Might miss out “b” col. Any valid approach using simplex
solution ft
comment cao</td></tr>
</table>

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>(v)</td><td></td><td>two-phase
<table>
<tr><th>A</th><th>I</th><th>b</th><th>c</th><th>f</th><th>s1</th><th>s2</th><th>s3</th><th>s4</th><th>a</th><th>RHS</th></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>–1</td><td>0</td><td>4</td></tr>
<tr><td>0</td><td>1</td><td>–30</td><td>–15</td><td>–3</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>15</td><td>6</td><td>2</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>100</td></tr>
<tr><td>0</td><td>0</td><td>4</td><td>2</td><td>$\frac{1}{2}$</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>30</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>4</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>–1</td><td>1</td><td>4</td></tr>
</table>
</td><td>B1
B1
B1</td><td>new objective
bowls ≤ 4
bowls ≥ 4</td></tr>
<tr><td></td><td></td><td></td><td>OR
big-M
<table>
<tr><th>I</th><th>b</th><th>c</th><th>f</th><th>s1</th><th>s2</th><th>s3</th><th>s4</th><th>RHS</th></tr>
<tr><td>1</td><td>–30–M</td><td>–15</td><td>–3</td><td>0</td><td>0</td><td>0</td><td>M</td><td>–4M</td></tr>
<tr><td>0</td><td>15</td><td>6</td><td>2</td><td>1</td><td>0</td><td>0</td><td>0</td><td>100</td></tr>
<tr><td>0</td><td>4</td><td>2</td><td>$\frac{1}{2}$</td><td>0</td><td>1</td><td>0</td><td>0</td><td>30</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>4</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>–1</td><td>4</td></tr>
</table>
</td><td>or
B1
B1
B1</td><td>objective
bowls ≤ 4
bowls ≥ 4</td></tr>
<tr><td></td><td></td><td></td><td>Special case ... Candidates may ignore the instruction and set up an ordinary simplex with b excluded and with reduced resources of £40 and 14 hours.</td><td>SC2</td><td>–1 each error</td></tr>
<tr><td></td><td></td><td></td><td></td><td>[3]</td><td></td></tr>
<tr><td>4</td><td>(vi)</td><td></td><td>4 bowls, 6 candle holders and 2 key fobs.
(Uses all of the budget. Leaves an hour to spare. Gives an income of £216.)</td><td>B1
[1]</td><td></td></tr>
<tr><td>4</td><td>(vii)</td><td></td><td>There might be another solution with less income, but even less expenditure.</td><td>B1
[1]</td><td></td></tr>
</table>

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GCE

Mathematics (MEI)

Advanced GCE **A2 7895-8**

Advanced Subsidiary GCE **AS 3895-8**

OCR Report to Centres

June 2013

Oxford Cambridge and RSA Examinations

4772 Decision Mathematics 2

General Comments

Most candidates did well with some of the modelling in Q2, but less well in Q4, where the detail involved in the computational aspects seemed to mitigate against higher level thinking.

Question 1(a) caused specific and significant difficulties – see below.

Question 3 was found to be routine.

Comments on Individual Questions

1) (a) Candidates were asked to consider simulated responses to a logic question. Very few candidates were able to cut through the convolutions of the given answers. Part (iv) illustrates this well. Candidates had only to note that “route” had been used instead of “arc”. There was, of course, a massive temptation to consider the ramifications of using “route”, but for only one mark, which was not required.

(b) Answered well.

(c) Answered very well

2) It was gratifying to see a large proportion of candidates answering part (i) well, and to see some answering part (ii) well. It is, of course, crucial in part (ii) to identify correctly the order of decisions and chances. Those who did not succeed usually had the wrong ordering, or had omitted the consult/don’t consult decision. The examiners are convinced of the value of this modelling, hoping that candidates who succeed with it now will find it useful in the future.

3) Most candidates had covered the network material well, and scored well throughout this question. If there was a weakness, it was in the final part, where few candidates considered all three pairings of odd nodes.

4) Whilst candidates generally ploughed through this question mechanistically, there was a strong developmental thread to it. The problem was degenerate - there were two vertices of the three-dimensional feasible region which were jointly optimal (as was any point on the line joining the two vertices). Candidates following through the given instructions should have first found, in part (iii), a non-integer solution. They were then led, in part (iv) to the adjacent solution, which was integer. Some candidates shortcut this process, but were credited appropriately.

In part (v), the set-up requires two new inequalities, that the number of bowls should be both less than or equal to 4 and greater than or equal to 4. Many candidates missed the first of these constraints.

A substantial minority of candidates lost marks and time in earlier parts of the question by formulating and maximising a profit function, whereas the question was quite specific in referring to income. In the final parts they and most other candidates made the error of assuming that part (vi) required the answer “4 bowls and 6 candle holders”, with part (vii) demanding “4 bowls, 6 candle holders and 2 key fobs”. In fact, part (vi) asked for the best integer solution, which was the latter of those two, and part (vii) was asking about using profit rather than income.

Some candidates gave answers which sensibly involved a three-month operational horizon, but this question had been clearly formulated in terms of the one-month problem.

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