OCR
Oxford Cambridge and RSA

Wednesday 7 June 2017 – 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 inside 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 barcodes.
- You are permitted to use a scientific or graphical calculator in this paper.
- Final answers should be given to a degree of accuracy appropriate to the context.

INFORMATION FOR CANDIDATES

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- 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)** The philosopher Epimenides is said to have stated "All Cretans are liars". Epimenides was a Cretan.

Analyse the statement, starting with a consideration of what might be meant when someone is said to be a liar. **[3]**

(b) **(i)** Use a truth table to prove that "$\wedge$" is distributive over "$\vee$", i.e. that $a \wedge (b \vee c) = (a \wedge b) \vee (a \wedge c)$. **[3]**

(ii) Use a truth table to prove that "$\vee$" is distributive over "$\wedge$". **[2]**

(c) **(i)** Explain why $(a \Rightarrow b) \Leftrightarrow (\sim a \vee b)$. **[1]**

(ii) Draw a combinatorial circuit for $(a \Rightarrow (b \vee c))$. **[3]**

(iii) Use Boolean algebra to prove that $\sim (a \wedge \sim (b \vee c)) \Leftrightarrow (a \Rightarrow (b \vee c))$. **[2]**

(iv) It is not the case that Adrian and neither Brian nor Claire were guilty. So, if Adrian was guilty, what can you deduce about Brian and Claire? State and prove. **[2]**

2 Yvette is to buy tickets for a one-way journey. She can choose between a scheduled airline, a budget airline and a charter airline. She knows the costs of the tickets and other travel costs, but she also wants to take account of the time of her journey. This varies between the airlines because they use different airports, and because the budget airline involves two connecting flights. The time is also subject to delay, which Yvette has researched. Yvette costs her time at £50 per hour.

Airline	Cost (i.e. all travel costs)	Total journey time (hours)	Probability of 1 hour delay	Probability of 2 hour delay	Probability of 24 hour delay
Scheduled	£180	3	0.05	0.01	0
Budget	£80	4.5	0.1	0.03	0.02*
Charter	£120	4	0.2	0.03	0

(*… as a consequence of missing the connecting flight)

(i) Draw a decision tree for Yvette. **[4]**

(ii) Evaluate the EMV at each node of your tree, and give the airline which minimises the EMV of the cost of Yvette's journey. **[8]**

(iii) Investigate the consequences of using a square root utility function applied to total costs. Give the airline with the best expected utility and that value. **[2]**

Yvette discovers a website which will tell her before she buys her tickets whether or not the budget airline plane for the first leg is delayed on its previous flight. If it is not delayed then the connection is assured, although other delays may take place as before.

(iv) What is the EMV of this information? **[2]**

3 **(a)** Consider applying Floyd's algorithm to a complete undirected network on 5 vertices to find the complete network of shortest routes.

(i) How many comparisons are needed during the first iteration? **[1]**

(ii) How many comparisons are needed in total? **[1]**

Now consider repeatedly applying Dijkstra's algorithm to a complete undirected network on 5 vertices. The first iteration finds all of the shortest routes from the first vertex. In the second iteration the first vertex and its arcs are deleted and all of the shortest routes are found from the second vertex … and so on.

(iii) How many comparisons are needed during the first iteration? **[2]**

(iv) How many comparisons are needed in total? **[2]**

(b) The unbracketed numbers in the table give direct distances between the vertices of a network, where direct connections exist. These are also the shortest distances. The bracketed numbers give shortest indirect distances, where no direct connections exist.

	A	B	C	D	E	F
A		32	27	(54)	41	31
B	32		38	22	45	33
C	27	38		(47)	18	(58)
D	(54)	22	(47)		29	23
E	41	45	18	29		(52)
F	31	33	(58)	23	(52)	

(i) By deleting A and its arcs, and by finding a minimum connector for the remaining vertices, construct a lower bound for the solution to the travelling salesperson problem in this network. **[4]**

(ii) Make three attempts to apply the nearest neighbour algorithm to find a good solution to the TSP. Start at vertex A for your first attempt, at vertex B for your second attempt and at vertex C for your final attempt, and give the best of your attempts. **[3]**

(iii) Use the route inspection algorithm to find an optimal solution to the Chinese postperson problem in the network. Give an optimal route. **[7]**

4 Ian the chef is constructing a recipe for a dish with four ingredients: pasta, sauce, cheese and olive oil. The fat, salt and sugar concentrations in each of his ingredients are listed in the table, all in units of grams per 100 grams. The table also shows the upper limits for concentrations which Ian does not want to exceed in constructing his recipe.

	pasta	sauce	cheese	olive oil	limits
fat	2	5	30	100	26
salt	0.05	1	2	0	1
sugar	3.5	2	0	0	2.5

The following LP is constructed to help Ian with constructing his recipe.

maximise $P = p1 + p2 + p3 + p4$
subject to $p1 + p2 + p3 + p4 \leqslant 1$
$2p1 + 5p2 + 30p3 + 100p4 \leqslant 26$
$0.05p1 + p2 + 2p3 \leqslant 1$
$3.5p1 + 2p2 \leqslant 2.5$
end

(i) Explain what p1, p2, p3 and p4 represent in this formulation. **[1]**

(ii) Set the problem up in an initial simplex tableau. **[5]**

(iii) Perform the first iteration of the Simplex algorithm. Pivot on an element in the p1 column. **[5]**

There are many solutions to the LP, including $\left(\frac{1}{3}, \frac{2}{3}, 0, 0\right)$ and $(0.405, 0.000, 0.490, 0.105)$, where the solutions are given in the form (p1, p2, p3, p4) either exact or correct to 3 decimal places.

(iv) Obtain the fat, salt and sugar concentrations for the two solutions quoted above. **[2]**

Ian adds the following constraints …

- The pasta content must be at least 40%.
- The sauce content must be at least 30%.
- There must be at least 10% cheese.
- There must be at least 5% olive oil.

(v) Extend your initial tableau from part (ii) to model this extended problem using two-phase Simplex. Do not attempt to solve the problem. **[6]**

An LP package gives a solution to this extended problem as (0.4, 0.3, 0.1, 0.2)

(vi) Interpret this solution. **[1]**

END OF QUESTION PAPER

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* 4 7 7 2 0 1 *

* 6 7 1 2 0 2 7 1 5 1 *

Candidate forename		Candidate surname	

Centre number						Candidate number				

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1 (a)	
1 (b) (i)	

1 (b) (ii)	
1 (c) (i)	
1 (c) (ii)	
1 (c) (iii)	
1 (c) (iv)	

2 (i)&(ii)	

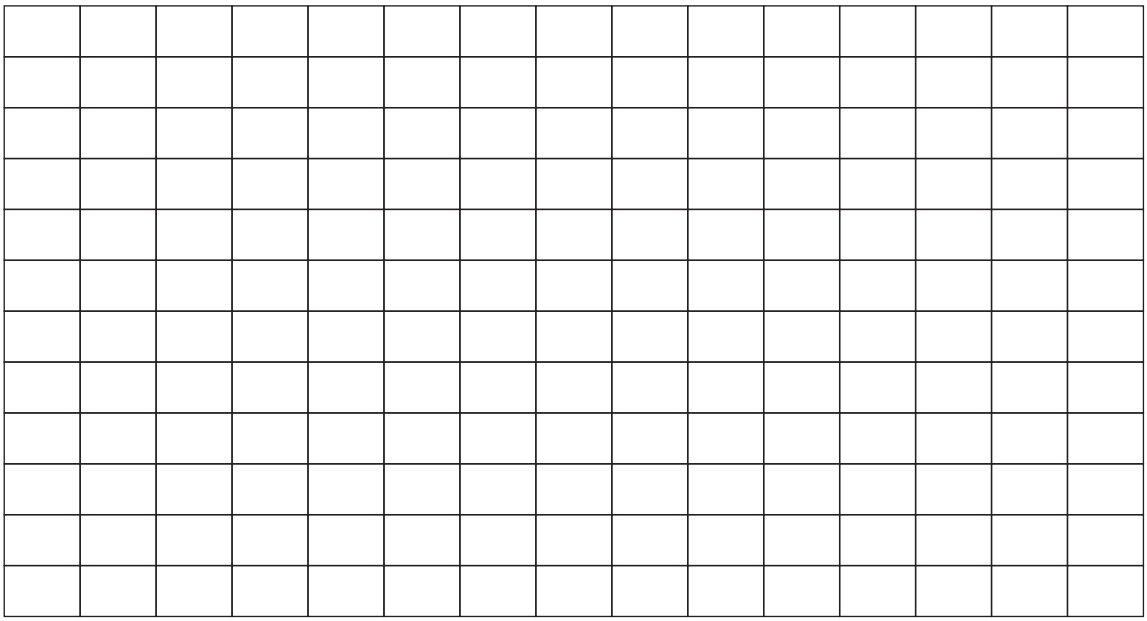
2 (iii)	
2 (iv)	

3 (a) (i)	
3 (a) (ii)	
3 (a) (iii)	
3 (a) (iv)	
3 (b) (i)	

3 (b) (ii)	
3 (b) (iii)	

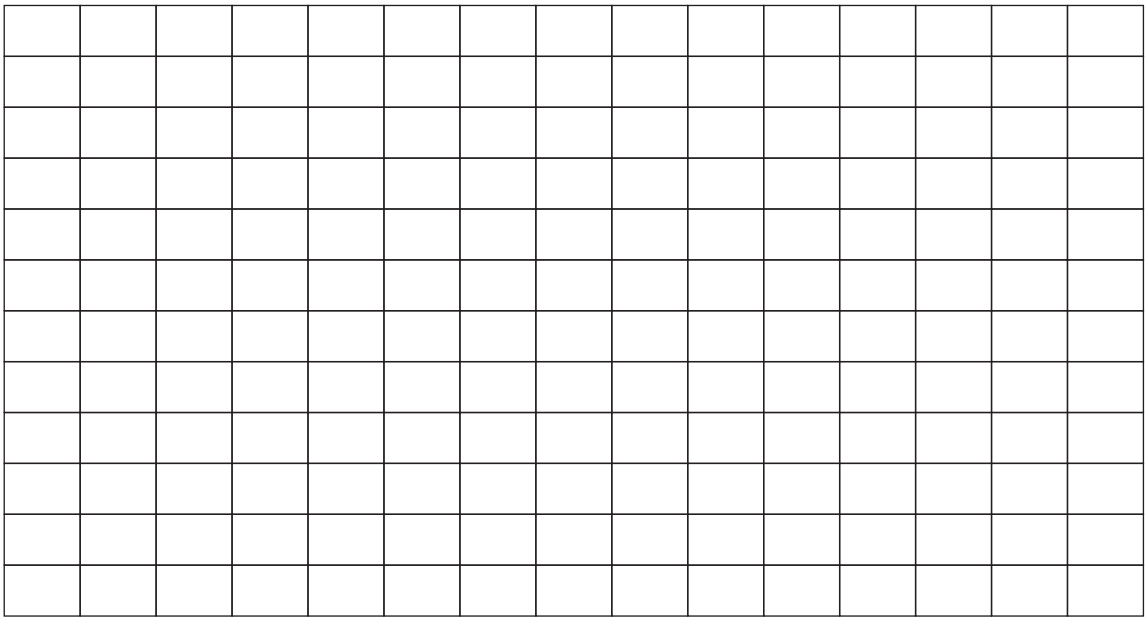
4 (i)

4 (ii)



A spare copy of this diagram can be found on p10

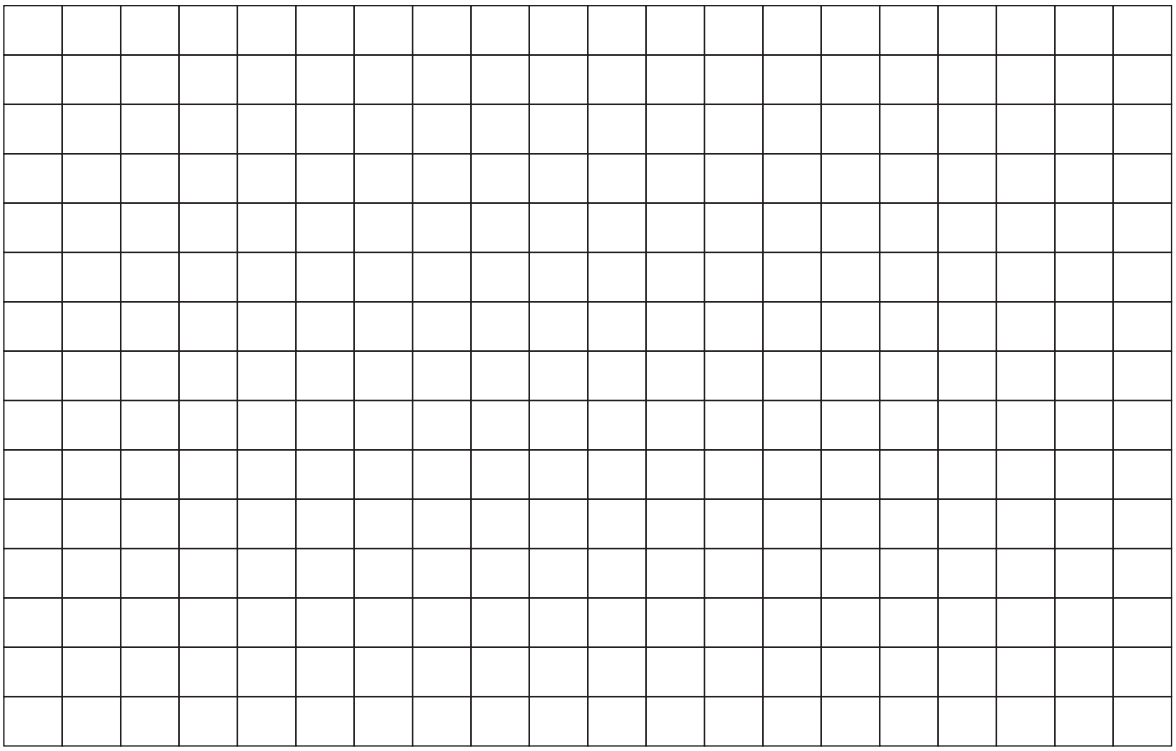
4 (iii)



A spare copy of this diagram can be found on p10

4 (iv)

4 (v)



A spare copy of this diagram can be found on p11

4 (vi)

4 (ii) **Spare copy of diagram for 4(ii)**

4 (iii) **Spare copy of diagram for 4(iii)**

4 (v) **Spare copy of diagram for 4(v)**

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OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4772**: Decision Mathematics 2

Advanced GCE

Mark Scheme for June 2017

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.

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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.

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

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>1</td><td>(a)</td><td></td><td>e.g. A workable definition of a liar is one who does not always tell the truth.

If Epimenides was telling the truth, then all Cretans were liars (which is unlikely since there were perhaps some 200000 inhabitants in Crete in 400 BC). This does not contradict the implication that he is a liar, given the above.
If Epimenides was lying then not all Cretans are liars, which is also not a contradiction.

(Note the liar paradox, “I am lying”, refers to one statement only.)</td><td>B1

M1A1</td><td>Sensible consideration of meaning

M1 for considering if Epimenides was telling the truth and if not
A1 for full argument</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>
<table>
<tr><th>a</th><th>∧</th><th>(b</th><th>∨</th><th>c)</th><th></th><th>(a</th><th>∧</th><th>b)</th><th>∨</th><th>(a</th><th>∧</th><th>c)</th></tr>
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</table>
</td><td>M1

B1

B1</td><td>8 rows

LHS

RHS</td></tr>
</table>

(ii)

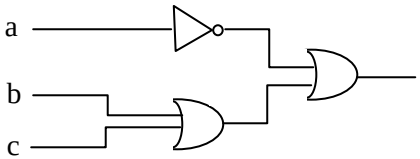
a	$\vee$	(b	$\wedge$	c)		(a	$\vee$	b)	$\wedge$	(a	$\vee$	c)
0	**0**	0	0	0		0	0	0	**0**	0	0	0
0	**0**	0	0	1		0	0	0	**0**	0	1	1
0	**0**	1	0	0		0	1	1	**0**	0	0	0
0	**1**	1	1	1		0	1	1	**1**	0	1	1
1	**1**	0	0	0		1	1	0	**1**	1	1	0
1	**1**	0	0	1		1	1	0	**1**	1	1	1
1	**1**	1	0	0		1	1	1	**1**	1	1	0
1	**1**	1	1	1		1	1	1	**1**	1	1	1

B1 LHS (cao)

B1 RHS (cao)

(c) (i) Both are only false when *a* is true and *b* is false. B1

(ii)



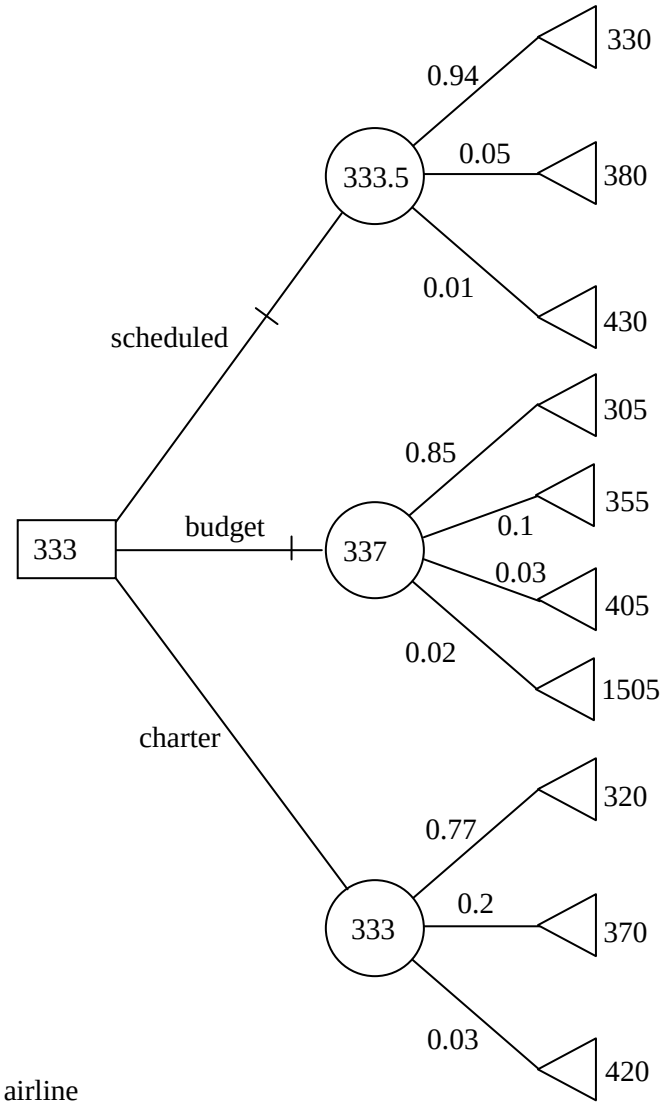
M1 uses (i)

A1 a "not"

A1 2 "or's"

(iii) $\sim\left(a\wedge\sim\left(b\vee c\right)\right)\Leftrightarrow\sim a\vee\left(b\vee c\right)\Leftrightarrow\left(a\Rightarrow\left(b\vee c\right)\right)$ by (i) B1 B1

(iv) Either Brian or Claire were guilty (or both), by (iii). B1 B1 "or both" not needed

Question	Answer	Marks	Guidance
2 (i)& (ii)	 Travel with the charter airline	M1 M1 A1 A1 M1 A1 M1 A1 M1 A1 B1 B1	decision node at first branch chance nodes at second branches 3 terminal nodes twice 4 terminal nodes once one cost OK all costs OK one “no delay” prob OK all probs OK one chance computation OK all chance computations OK £333 quoted or in decision box decision

	(iii)		Utilities are 18.26, 18.11, 18.24 respectively, so travel with the budget airline. Common errors … 12.38, 15.70 and 14.57 … allowed on ft. Common errors … 13.53, 9.86, 11.49 … allowed on ft	M1 A1	one of 18.11 or 18.24 all correct, plus decision
	(iv)		EMV = £333 - £313 = £20 (Computation of £313 uses probabilities of 0.87, 0.1 and 0.03) Common error … budget becomes £233. for B1 only.	B1 B1	computation of £313 √ subtraction from £333 cao

Question			Answer	Marks	Guidance
3	(a)	(i)	10 (16 if not exploiting symmetry) (6 or 12 if no diagonal)	B1 (B1) (0)	 but follow subsequently
		(ii)	50	B1	or 80 or 30 or 60 from above
		(iii)	(3+3) + (2+2) + (1+1) = 12	M1A1	(3+3)or(2+2)or(1+1) M1
		(iv)	12 + 6 + 2 = 20	M1A1	12 or 6 seen within three parts for M1
	(b)	(i)	Min connector has length 18 + 22 + 23 + 29 = 92 Add back in 27 and 31 giving an lower bound of 150	M1A1 M1A1	M1 for 4 arcs M1 for adding 2 A1√
		(ii)	**A** 27 **C** 18 **E** 29 **D** 22 **B** 33 **F** 31 **A** … 160 **B** 22 **D** 23 **F** 31 **A** 27 **C** 18 **E** 45 **B** … 166 **C** 18 **E** 29 **D** 22 **B** 32 **A** 31 **F** … stall	M1 B1 A1	160 and 166 stall ACEDBFA given or indicated
		(iii)	Odd vertices are B, C, D and F. Pairings … BC – 38 and DF – 23 … 61 BD – 22 and CF – 58 … 80 BF – 33 and CD – 47 … 80 So repeat BC and DF, giving for instance … **A** 32 **B** 38 **C** 38 **B** 22 **D** 29 **E** 18 **C** 27 **A** 41 **E** 45 **B** 33 **F** 23 **D** 23 **F** 31 **A** … 400	M1 A1 A1 A1 M1 A1 A1	

<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>the proportions of each ingredient</td><td>B1</td><td></td></tr>
<tr><td></td><td>(ii)</td><td></td><td>
<table>
<tr><td>P</td><td>p1</td><td>p2</td><td>p3</td><td>p4</td><td>s1</td><td>s2</td><td>s3</td><td>s4</td><td>RHS</td></tr>
<tr><td>1</td><td>-1</td><td>-1</td><td>-1</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
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<tr><td>0</td><td>0.05</td><td>1</td><td>2</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>0</td><td>3.5</td><td>2</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>2.5</td></tr>
</table>
</td><td>B1
B4</td><td>objective
constraints</td></tr>
<tr><td></td><td>(iii)</td><td></td><td>
<table>
<tr><td>P</td><td>p1</td><td>p2</td><td>p3</td><td>p4</td><td>s1</td><td>s2</td><td>s3</td><td>s4</td><td>RHS</td></tr>
<tr><td>1</td><td>0</td><td>$-\frac{3}{7}$</td><td>-1</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>$\frac{2}{7}$</td><td>$\frac{5}{7}$</td></tr>
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<tr><td>0</td><td>0</td><td>$\frac{27}{7}$</td><td>30</td><td>100</td><td>0</td><td>1</td><td>0</td><td>$-\frac{4}{7}$</td><td>$24\frac{4}{7}$</td></tr>
<tr><td>0</td><td>0</td><td>$\frac{34}{35}$</td><td>2</td><td>0</td><td>0</td><td>0</td><td>1</td><td>$-\frac{1}{70}$</td><td>$\frac{27}{28}$</td></tr>
<tr><td>0</td><td>1</td><td>$\frac{4}{7}$</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>$\frac{2}{7}$</td><td>$\frac{5}{7}$</td></tr>
</table>
</td><td>M1
A4</td><td>correct pivot
one for each of first 4 rows</td></tr>
<tr><td></td><td>(iv)</td><td></td><td>(4, 0.683333, 2.5) and (26, 1, 1.4175)</td><td>B1 B1</td><td>mark 26.01 and 1.00025 as correct</td></tr>
</table>

	(v)		<table><tr><td>A</td><td>P</td><td>p1</td><td>p2</td><td>p3</td><td>p4</td><td>s1</td><td>s2</td><td>s3</td><td>s4</td><td>s5</td><td>s6</td><td>s7</td><td>s8</td><td>a1</td><td>a2</td><td>a3</td><td>a4</td><td>RHS</td></tr><tr><td>1</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>-1</td><td>-1</td><td>-1</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0.85</td></tr><tr><td>0</td><td>1</td><td>-1</td><td>-1</td><td>-1</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</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>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>2</td><td>5</td><td>30</td><td>100</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td>26</td></tr><tr><td>0</td><td>0</td><td>0.05</td><td>1</td><td>2</td><td>0</td><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>0</td><td>0</td><td>0</td><td>0</td><td>1</td></tr><tr><td>0</td><td>0</td><td>3.5</td><td>2</td><td>0</td><td>0</td><td>0</td><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>0</td><td>0</td><td>0</td><td>2.5</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>0</td><td>0</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0.4</td></tr><tr><td>0</td><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>0</td><td>0</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0.3</td></tr><tr><td>0</td><td>0</td><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>0</td><td>0</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0.1</td></tr><tr><td>0</td><td>0</td><td>0</td><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>0</td><td>0</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0.05</td></tr></table>	M1A1 B1 B1 M1 A1	new objective 4 surplus variables 4 additional variables 4 new constraints all correct
	(vi)		Proportions as given. Concentrations are (25.3, 0.52, 2).	B1	

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4772 Decision Mathematics 2

General Comments:

The candidature for this paper was much reduced this year. These candidates were clearly good mathematicians who were well-prepared for the paper. However there were some difficult parts to the paper, including two part questions on counting which proved to be very challenging.

Comments on Individual Questions:

Question No. 1

The first part of the logic question was very challenging, and few candidates scored all three marks. The question invited candidates to explore the apparent paradox of Epimenides. Few considered carefully what might be meant when someone is said to be a liar. Far too many seemed to think that the negation of "All Cretans are liars" is that "No Cretans are liars".

The rest of the question was solidly grounded in learned techniques, and most parts were answered very well. Not all candidates realised that the result in (c)(iii) was intended to provide the means for the proof asked for in (c)(iv).

Question No. 2

This question was very well answered. The majority of candidates scored full marks on parts (i) and (ii), which was very pleasing. Part (iii), utility, was also done well. Part (iv) was a little more problematic. Many failed to get a new EMV of £313. Of those that did, few then subtracted it from their EMV from part (ii). Not all attempted a subtraction and many who did, subtracted their new "Budget" EMV from their Budget EMV in part (ii), instead of from their overall EMV.

Question No. 3

Parts (a)(i) and (a)(ii) were appropriately challenging, and the majority of candidates could answer them. Parts (a)(iii) and (a)(iv) turned out to be too difficult for the majority of candidates.

In part (b) more information was given than the lengths of arcs. Candidates were also told that direct arcs were shortest distances, and were given other shortest distances where there were no direct connections. This caused some confusion in (b)(ii), where the nearest neighbour algorithm starting at C stalls, but where almost all candidates carried on. It also caused confusion for a few in (b)(iii), when they thought that indirect connections were not allowed in pairings. Apart from that, and from the difficulties which some candidates had in giving a route in (b)(iii), part (b) was done well.

Question No. 4

It is almost always the case that LP formulations should start with "Let … be the number of …". This question was an exception, and only a very few candidates saw that. Of those that did, some were confused between concentrations (of fat, salt and sugar) and proportions (of pasta, sauce, cheese and olive oil).

Parts (ii), (iii) and (v) were done superbly well … candidates were very well prepared.

Most answered part (iv), although not always very efficiently, but few thought to provide the same interpretation in part (vi).

Unit level raw mark and UMS grade boundaries June 2017 series

For more information about results and grade calculations, see www.ocr.org.uk/ocr-for/learners-and-parents/getting-your-results

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 (AS)	Raw	72	63	58	53	49	45	0
			UMS	100	80	70	60	50	40	0
4752	01	C2 – MEI Concepts for advanced mathematics (AS)	Raw	72	55	49	44	39	34	0
			UMS	100	80	70	60	50	40	0
4753	01	(C3) MEI Methods for Advanced Mathematics with Coursework: Written Paper	Raw	72	54	49	45	41	36	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
			UMS	100	80	70	60	50	40	0
4754	01	C4 – MEI Applications of advanced mathematics (A2)	Raw	90	67	61	55	49	43	0
			UMS	100	80	70	60	50	40	0
4755	01	FP1 – MEI Further concepts for advanced mathematics (AS)	Raw	72	57	52	47	42	38	0
			UMS	100	80	70	60	50	40	0
4756	01	FP2 – MEI Further methods for advanced mathematics (A2)	Raw	72	65	58	52	46	40	0
			UMS	100	80	70	60	50	40	0
4757	01	FP3 – MEI Further applications of advanced mathematics (A2)	Raw	72	64	56	48	41	34	0
			UMS	100	80	70	60	50	40	0
4758	01	(DE) MEI Differential Equations with Coursework: Written Paper	Raw	72	63	56	50	44	37	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
			UMS	100	80	70	60	50	40	0
4761	01	M1 – MEI Mechanics 1 (AS)	Raw	72	57	49	41	34	27	0
			UMS	100	80	70	60	50	40	0
4762	01	M2 – MEI Mechanics 2 (A2)	Raw	72	56	48	41	34	27	0
			UMS	100	80	70	60	50	40	0
4763	01	M3 – MEI Mechanics 3 (A2)	Raw	72	58	50	43	36	29	0
			UMS	100	80	70	60	50	40	0
4764	01	M4 – MEI Mechanics 4 (A2)	Raw	72	53	45	38	31	24	0
			UMS	100	80	70	60	50	40	0
4766	01	S1 – MEI Statistics 1 (AS)	Raw	72	61	55	49	43	37	0
			UMS	100	80	70	60	50	40	0
4767	01	S2 – MEI Statistics 2 (A2)	Raw	72	56	50	45	40	35	0
			UMS	100	80	70	60	50	40	0
4768	01	S3 – MEI Statistics 3 (A2)	Raw	72	63	57	51	46	41	0
			UMS	100	80	70	60	50	40	0
4769	01	S4 – MEI Statistics 4 (A2)	Raw	72	56	49	42	35	28	0
			UMS	100	80	70	60	50	40	0
4771	01	D1 – MEI Decision mathematics 1 (AS)	Raw	72	52	46	41	36	31	0
			UMS	100	80	70	60	50	40	0
4772	01	D2 – MEI Decision mathematics 2 (A2)	Raw	72	53	48	43	39	35	0
			UMS	100	80	70	60	50	40	0
4773	01	DC – MEI Decision mathematics computation (A2)	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	58	53	48	43	37	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
			UMS	100	80	70	60	50	40	0
4777	01	NC – MEI Numerical computation (A2)	Raw	72	55	48	41	34	27	0

		UMS	100	80	70	60	50	40	0
4798	01 FPT - Further pure mathematics with technology (A2)	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 Statistics 1 MEI (Z1)	Raw	72	61	55	49	43	37	0
		UMS	100	80	70	60	50	40	0
G242	01 Statistics 2 MEI (Z2)	Raw	72	55	48	41	34	27	0
		UMS	100	80	70	60	50	40	0
G243	01 Statistics 3 MEI (Z3)	Raw	72	56	48	41	34	27	0
		UMS	100	80	70	60	50	40	0

GCE Quantitative Methods (MEI)

			Max Mark	a	b	c	d	e	u
G244	01 Introduction to Quantitative Methods MEI	Raw	72	58	50	43	36	28	0
G244	02 Introduction to Quantitative Methods MEI	Raw	18	14	12	10	8	7	0
		UMS	100	80	70	60	50	40	0
G245	01 Statistics 1 MEI	Raw	72	61	55	49	43	37	0
		UMS	100	80	70	60	50	40	0
G246	01 Decision 1 MEI	Raw	72	52	46	41	36	31	0
		UMS	100	80	70	60	50	40	0

Level 3 Certificate and FSMQ raw mark grade boundaries June 2017 series

For more information about results and grade calculations, see www.ocr.org.uk/ocr-for/learners-and-parents/getting-your-results

Level 3 Certificate Mathematics for Engineering

			Max Mark	a*	a	b	c	d	e	u
H860	01	Mathematics for Engineering	This unit has no entries in June 2017							
H860	02	Mathematics for Engineering								

Level 3 Certificate Mathematical Techniques and Applications for Engineers

				Max Mark	a*	a	b	c	d	e	u
H865	01	Component 1	Raw	60	48	42	36	30	24	18	0

Level 3 Certificate Mathematics - Quantitative Reasoning (MEI) (GQ Reform)

				Max Mark	a	b	c	d	e	u
H866	01	Introduction to quantitative reasoning	Raw	72	54	47	40	34	28	0
H866	02	Critical maths	Raw	60*	48	42	36	30	24	0
		*Component 02 is weighted to give marks out of 72	Overall	144	112	97	83	70	57	0

Level 3 Certificate Mathematics - Quantitive Problem Solving (MEI) (GQ Reform)

				Max Mark	a	b	c	d	e	u
H867	01	Introduction to quantitative reasoning	Raw	72	54	47	40	34	28	0
H867	02	Statistical problem solving	Raw	60*	41	36	31	27	23	0
		*Component 02 is weighted to give marks out of 72	Overall	144	103	90	77	66	56	0

Advanced Free Standing Mathematics Qualification (FSMQ)

				Max Mark	a	b	c	d	e	u
6993	01	Additional Mathematics	Raw	100	72	63	55	47	39	0

Intermediate Free Standing Mathematics Qualification (FSMQ)

				Max Mark	a	b	c	d	e	u
6989	01	Foundations of Advanced Mathematics (MEI)	Raw	40	35	30	25	20	16	0