OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4772**: Decision Mathematics 2

Advanced GCE

Mark Scheme for June 2017

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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>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td></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>0</td><td>1</td><td>1</td><td></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>1</td><td>1</td><td>0</td><td></td><td>0</td><td>0</td><td>1</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></td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td>1</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>1</td><td></td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td></td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td></td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
</table>
</td><td>M1

B1

B1</td><td>8 rows

LHS

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

(ii)

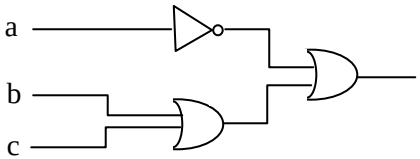
a	$\vee$	(b	$\wedge$	c)		(a	$\vee$	b)	$\wedge$	(a	$\vee$	c)
0	**0**	0	0	0		0	0	0	**0**	0	0	0
0	**0**	0	0	1		0	0	0	**0**	0	1	1
0	**0**	1	0	0		0	1	1	**0**	0	0	0
0	**1**	1	1	1		0	1	1	**1**	0	1	1
1	**1**	0	0	0		1	1	0	**1**	1	1	0
1	**1**	0	0	1		1	1	0	**1**	1	1	1
1	**1**	1	0	0		1	1	1	**1**	1	1	0
1	**1**	1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



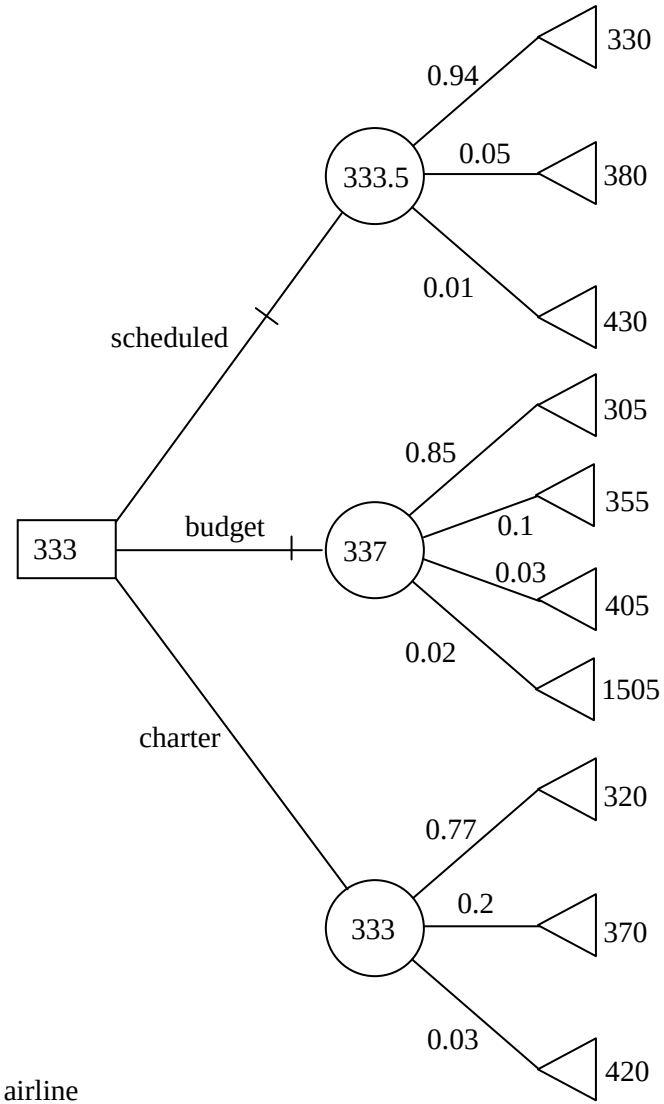
M1 uses (i)

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>
<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>1</td></tr>
<tr><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>26</td></tr>
<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>
<tr><td>0</td><td>0</td><td>$\frac{3}{7}$</td><td>1</td><td>1</td><td>1</td><td>0</td><td>0</td><td>$-\frac{2}{7}$</td><td>$\frac{2}{7}$</td></tr>
<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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