OCR
Oxford Cambridge and RSA

GCE

Mathematics (MEI)

Unit **4772**: Decision Mathematics 2

Advanced GCE

Mark Scheme for June 2014

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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.

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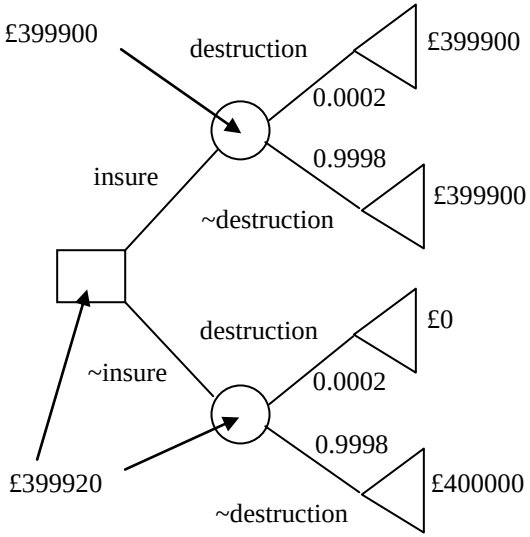
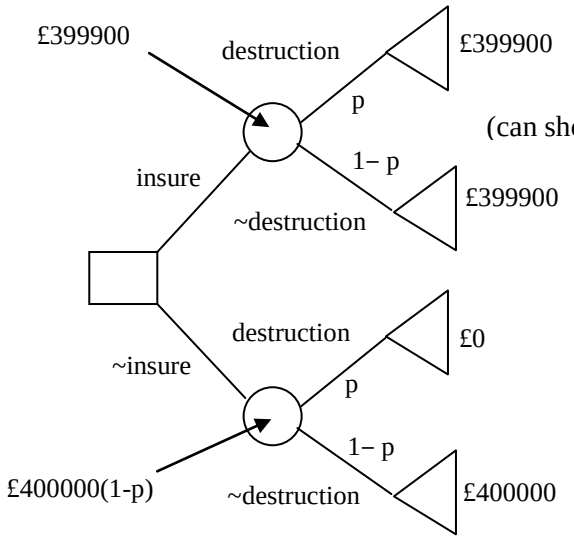
Question			Answer	Marks	Guidance
1	(i) (ii)		 EMV is £399920, by not insuring.	M1 A1 M1 A1 M1 A1 B1 B1	Decision node (with labels) insure chance nodes (with labels) (can show just one arc) ~insure chance node (with labels) EMV course of action
	(iii)		£80	B1	
	(iv)		Insuring has a utility of $\sqrt{399900}$ = 632.3765 Not insuring has a utility of $0.9998\times\sqrt{400000}$ = 632.329 So utility is maximised by insuring.	M1 A1 B1	prob$\times\sqrt{\text{value}}$ not $\sqrt{\text{prob}\times\text{value}}$ both utilities (cao) www

Question	Answer	Marks	Guidance
(v)	 (can show 399900 with probability 1)	B1	*p* used on ~ insure branch
(vi)	The condition for insurance to be worthwhile is that 399900 > 400000(1− p) i.e. p > 0.00025.	M1 A1	cao
(vii)	The EMV analysis does not take adequate account of the loss caused by destruction. That is why the concept of utility is needed.	B1	

Question			Answer	Marks	Guidance
2	(a)	(i)	Either the ball hit the bat or it did not. If it hit the bat then the batsman is out caught. If it did not hit the bat then he is out LBW. In both cases he is out, and there is no other possibility.	M1 A1 A1	 or equivalent
		(ii)	$\sim lb \Rightarrow b$	B1	
		(iii)	$\sim c \Rightarrow \sim b$	B1	
		(iv)	$\sim o \Rightarrow (\sim lb \wedge \sim c) \Rightarrow (b \wedge \sim b)$	B1	
		(v)	$\sim(b \wedge \sim b) \Rightarrow o$	M1 A1	reversing and negating cao

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>2</td><td>(b)</td><td>(i)</td><td>$d \Rightarrow (a \vee b \vee c)$, or equivalent</td><td>B1</td><td></td></tr>
<tr><td>2</td><td>(b)</td><td>(ii)</td><td>
<table>
<tr><th>a</th><th>b</th><th>c</th><th>d</th><th></th><th>(d</th><th>$\Rightarrow$</th><th>(a∨b∨c))</th><th></th><th>$\wedge$</th><th></th><th>~</th><th>(b∨c)</th></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td></td><td>0</td><td>1</td><td>0</td><td></td><td>1</td><td></td><td>1</td><td>0</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td></td><td>1</td><td>0</td><td>0</td><td></td><td>0</td><td></td><td>1</td><td>0</td></tr>
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<tr><td>1</td><td>1</td><td>0</td><td>1</td><td></td><td>1</td><td>1</td><td>1</td><td></td><td>0</td><td></td><td>0</td><td>1</td></tr>
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<tr><td>1</td><td>1</td><td>1</td><td>1</td><td></td><td>1</td><td>1</td><td>1</td><td></td><td>0</td><td></td><td>0</td><td>1</td></tr>
</table>
</td><td>M1

A1
A1
A1</td><td>16 rows covering all possibilities

$d \Rightarrow (a \vee b \vee c)$
$\sim(b \vee c)$
overall conjunction √</td></tr>
<tr><td>2</td><td>(b)</td><td>(iii)</td><td>Either A,
or (A and D),
or none of them</td><td>B1
B1
B1</td><td>

Disallowed by the stem, but allowed by the table!</td></tr>
</table>

<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></td><td>Let a be the number of kg of A …
Line 1 ⇔ max (7-3)a+(5-2)b+(4-3)c ⇔ 4a+3b+c

Line 2 ⇔ 10a+5b+12c ≤ 12000 (availability of X)
Line 3 ⇔ 5a+5b+7c ≤ 12000 (availability of Y)
Line 4 ⇔ 5a+3b+5c ≤ 9000 (availability of Z)</td><td>B1
B1
B1
B1
B1
B1</td><td>variable defs.
objective
(7-3) ...
identifying constraints
LHS (used)
≤ + RHS (available)</td></tr>
<tr><td></td><td>(ii)</td><td></td><td>
<table>
<tr><td>P</td><td>a</td><td>b</td><td>c</td><td>s1</td><td>s2</td><td>s3</td><td>RHS</td></tr>
<tr><td>1</td><td>-4</td><td>-3</td><td>-1</td><td>0</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>10</td><td>5</td><td>12</td><td>1</td><td>0</td><td>0</td><td>12000</td></tr>
<tr><td>0</td><td>5</td><td>5</td><td>7</td><td>0</td><td>1</td><td>0</td><td>12000</td></tr>
<tr><td>0</td><td>5</td><td>3</td><td>5</td><td>0</td><td>0</td><td>1</td><td>9000</td></tr>
<tr><td>1</td><td>0</td><td>-1</td><td>3.8</td><td>0.4</td><td>0</td><td>0</td><td>4800</td></tr>
<tr><td>0</td><td>1</td><td>0.5</td><td>1.2</td><td>0.1</td><td>0</td><td>0</td><td>1200</td></tr>
<tr><td>0</td><td>0</td><td>2.5</td><td>1</td><td>-0.5</td><td>1</td><td>0</td><td>6000</td></tr>
<tr><td>0</td><td>0</td><td>0.5</td><td>-1</td><td>-0.5</td><td>0</td><td>1</td><td>3000</td></tr>
</table>
or
<table>
<tr><td>1</td><td>2</td><td>0</td><td>6.2</td><td>0.6</td><td>0</td><td>0</td><td>7200</td><td>1</td><td>0</td><td>0</td><td>4.2</td><td>0.2</td><td>0.4</td><td>0</td><td>7200</td></tr>
<tr><td>0</td><td>2</td><td>1</td><td>2.4</td><td>0.2</td><td>0</td><td>0</td><td>2400</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0.2</td><td>-0.2</td><td>0</td><td>0</td></tr>
<tr><td>0</td><td>-5</td><td>0</td><td>-5</td><td>-1</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>0.4</td><td>-0.2</td><td>0.4</td><td>0</td><td>2400</td></tr>
<tr><td>0</td><td>-1</td><td>0</td><td>-2.2</td><td>-0.6</td><td>0</td><td>1</td><td>1800</td><td>0</td><td>0</td><td>0</td><td>-1.2</td><td>-0.4</td><td>-0.2</td><td>1</td><td>1800</td></tr>
</table>

Make 2400 kg of B
at a profit of £7200 with 1.8kg of Z left</td><td>B1
M1A1

B1
M1
A1

B1
B1</td><td>Pivot

Pivot √

cao

must refer to kg</td></tr>
<tr><td></td><td>(iii)</td><td></td><td>Either ... It means that the second constraint is coincidentally exactly satisfied at the solution.
or ... It means that product A is in the solution, but at zero value.
(Candidates may refer to degeneracy, which will earn the mark.)</td><td>B1</td><td></td></tr>
</table>

Question	Answer	Marks	Guidance
(iv)			

Q	P	a	b	c	s1	s2	s3	s4	f	RHS
1	0	1	0	0	0	0	0	-1	0	500
0	1	-4	-3	-1	0	0	0	0	0	0
0	0	10	5	12	1	0	0	0	0	12000
0	0	5	5	7	0	1	0	0	0	12000
0	0	5	3	5	0	0	1	0	0	9000
0	0	1	0	0	0	0	0	-1	1	500

Minimise Q until 0 (if feasible). — B1 — new objective
Then drop Q and f and proceed to optimum. — B1 — surplus+artificial

Allow up to 3 out of 5 for big M. — B1 — new constraint

<table>
<tr><th colspan="3">Question</th><th>Answer</th><th>Marks</th><th>Guidance</th></tr>
<tr><td>4</td><td>(a)</td><td>(i)</td><td>Dijkstra starting at A
working values
order of labelling
labels

4 more starting points on 5, 4, 3, 2 vertices (or more likely and tediously 5 more, each on 6 vertices).</td><td>B1
B1
B1
B1

M1
A2</td><td>update at D
working values
order of labelling
labels

-1 each error</td></tr>
<tr><td>4</td><td>(a)</td><td>(ii)</td><td><table><tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th><th>F</th></tr><tr><td>A</td><td>–</td><td>5</td><td>8</td><td>8</td><td>2</td><td>3</td></tr><tr><td>B</td><td>5</td><td>–</td><td>3</td><td>8</td><td>7</td><td>8</td></tr><tr><td>C</td><td>8</td><td>3</td><td>–</td><td>5</td><td>10</td><td>6</td></tr><tr><td>D</td><td>8</td><td>8</td><td>5</td><td>–</td><td>6</td><td>10</td></tr><tr><td>E</td><td>2</td><td>7</td><td>10</td><td>6</td><td>–</td><td>5</td></tr><tr><td>F</td><td>3</td><td>8</td><td>6</td><td>10</td><td>5</td><td>–</td></tr></table></td><td>B2</td><td>– 1 each error</td></tr>
<tr><td>4</td><td>(a)</td><td>(iii)</td><td>Max of a row or a column
Minimum of the maxima
A, B, or A or B</td><td>M1
M1
A1</td><td>

dependent on both Ms</td></tr>
<tr><td>4</td><td>(a)</td><td>(iv)</td><td>From a point on AB the route to D is via A or B, and from part (ii) therefore exceeds 8.</td><td>B1</td><td></td></tr>
<tr><td>4</td><td>(b)</td><td>(i)</td><td>A 2 E 6 D 5 C 3 B 9 F 3 A
So F A E D C B with total length 19</td><td>M1A1
B1</td><td></td></tr>
<tr><td>4</td><td>(b)</td><td>(ii)</td><td>B 3 C 5 D 6 E 2 A 3 F 9 B so F B C D E A – 19
C 3 B 5 A 2 E 6 D 10 F 6 C so F C B A E D – 22
D 5 C 3 B 5 A 2 E stuck
E 2 A 3 F 6 C 3 B 9 D 6 E so D E A F C B – 20
F 3 A 2 E 6 D 5 C 3 B 8 F so F A E D C B – 19

So 19 is min length with either listing given.</td><td>B3

B1</td><td>– 1 for each error, including failing to stop when starting from D</td></tr>
</table>

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