



GCE
Mathematics (MEI)

Unit **4772**: Decision Mathematics 2

Advanced GCE

Mark Scheme for June 2014

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Question	Answer	Marks	Guidance
1 (i) (ii)	<p>EMV is £399920, by not insuring.</p>	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)	<p>Insuring has a utility of $\sqrt{399900} = 632.3765$</p> <p>Not insuring has a utility of $0.9998 \times \sqrt{400000} = 632.329$</p> <p>So utility is maximised by insuring.</p>	M1 A1 B1	prob \times $\sqrt{\text{value}}$ not $\sqrt{\text{prob} \times \text{value}}$ both utilities (cao) www

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

Question			Answer									Marks	Guidance																																																																																																									
3	(i)		Let a be the number of kg of A ... Line 1 $\Leftrightarrow \max (7-3)a + (5-2)b + (4-3)c \Leftrightarrow 4a + 3b + c$ Line 2 $\Leftrightarrow 10a + 5b + 12c \leq 12000$ (availability of X) Line 3 $\Leftrightarrow 5a + 5b + 7c \leq 12000$ (availability of Y) Line 4 $\Leftrightarrow 5a + 3b + 5c \leq 9000$ (availability of Z)									B1 B1 B1 B1 B1 B1	variable defs. objective (7-3) ... identifying constraints LHS (used) \leq + RHS (available)																																																																																																									
	(ii)		<table border="1" style="display: inline-table; vertical-align: middle;"> <thead> <tr> <th>P</th><th>a</th><th>b</th><th>c</th><th>s1</th><th>s2</th><th>s3</th><th>RHS</th></tr> </thead> <tbody> <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> <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></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></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></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></tr> </tbody> </table> or										P	a	b	c	s1	s2	s3	RHS	1	-4	-3	-1	0	0	0	0	0	10	5	12	1	0	0	12000	0	5	5	7	0	1	0	12000	0	5	3	5	0	0	1	9000	1	0	-1	3.8	0.4	0	0	4800	0	1	0.5	1.2	0.1	0	0	1200	0	0	2.5	1	-0.5	1	0	6000	0	0	0.5	-1	-0.5	0	1	3000	1	2	0	6.2	0.6	0	0	7200	0	2	1	2.4	0.2	0	0	2400	0	-5	0	-5	-1	1	0	0	0	-1	0	-2.2	-0.6	0	1	1800	B1 M1A1 B1 M1 A1 B1 B1	Pivot Pivot ✓ cao must refer to kg
P	a	b	c	s1	s2	s3	RHS																																																																																																															
1	-4	-3	-1	0	0	0	0																																																																																																															
0	10	5	12	1	0	0	12000																																																																																																															
0	5	5	7	0	1	0	12000																																																																																																															
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0	-1	0	-2.2	-0.6	0	1	1800																																																																																																															
			Make 2400 kg of B at a profit of £7200 with 1.8kg of Z left																																																																																																																			
	(iii)		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.)									B1																																																																																																										

Question		Answer											Marks	Guidance																																																																															
	(iv)	<table border="1"> <thead> <tr> <th>Q</th><th>P</th><th>a</th><th>b</th><th>c</th><th>s1</th><th>s2</th><th>s3</th><th>s4</th><th>f</th><th>RHS</th></tr> </thead> <tbody> <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>500</td></tr> <tr><td>0</td><td>1</td><td>-4</td><td>-3</td><td>-1</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>10</td><td>5</td><td>12</td><td>1</td><td>0</td><td>0</td><td>0</td><td>0</td><td>12000</td></tr> <tr><td>0</td><td>0</td><td>5</td><td>5</td><td>7</td><td>0</td><td>1</td><td>0</td><td>0</td><td>0</td><td>12000</td></tr> <tr><td>0</td><td>0</td><td>5</td><td>3</td><td>5</td><td>0</td><td>0</td><td>1</td><td>0</td><td>0</td><td>9000</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>500</td></tr> </tbody> </table> <p>Minimise Q until 0 (if feasible). Then drop Q and f and proceed to optimum. Allow up to 3 out of 5 for big M.</p>													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	B1 B1 B1 B1 B1	new objective surplus+artificial new constraint
Q	P	a	b	c	s1	s2	s3	s4	f	RHS																																																																																			
1	0	1	0	0	0	0	0	-1	0	500																																																																																			
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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																																																																																			

Question			Answer	Marks	Guidance																																																	
4	(a)	(i)	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).	B1 B1 B1 B1 M1 A2	update at D working values order of labelling labels -1 each error																																																	
4	(a)	(ii)	<table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td><td>F</td></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>		A	B	C	D	E	F	A	-	5	8	8	2	3	B	5	-	3	8	7	8	C	8	3	-	5	10	6	D	8	8	5	-	6	10	E	2	7	10	6	-	5	F	3	8	6	10	5	-	B2	- 1 each error
	A	B	C	D	E	F																																																
A	-	5	8	8	2	3																																																
B	5	-	3	8	7	8																																																
C	8	3	-	5	10	6																																																
D	8	8	5	-	6	10																																																
E	2	7	10	6	-	5																																																
F	3	8	6	10	5	-																																																
4	(a)	(iii)	Max of a row or a column Minimum of the maxima A, B, or A or B	M1 M1 A1	dependent on both Ms																																																	
4	(a)	(iv)	From a point on AB the route to D is via A or B, and from part (ii) therefore exceeds 8.	B1																																																		
4	(b)	(i)	A 2 E 6 D 5 C 3 B 9 F 3 A So F A E D C B with total length 19	M1A1 B1																																																		
4	(b)	(ii)	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.	B3 B1	- 1 for each error, including failing to stop when starting from D																																																	

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