



GCE

Mathematics

Advanced GCE

Unit 4737: Decision Mathematics 2

Mark Scheme for June 2011

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

© OCR 2011

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

1	(i)	<p>Cornflakes (1) ● (A) Adam</p> <p>Rice pips (2) ● (B) Barbara</p> <p>Wheat biscuits (3) ● (C) Charlie</p> <p>Oatie bits (4) ● (D) Donna</p> <p>Choco pips (5) ● (E) Edward</p> <p>Honey footballs (6) ● (F) Fiona</p>	B1	[1]	Bipartite graph correct	Condone any extra labels (working)	
	(ii)	<p>Cornflakes (1) ● (A) Adam</p> <p>Rice pips (2) ● (B) Barbara</p> <p>Wheat biscuits (3) ● (C) Charlie</p> <p>Oatie bits (4) ● (D) Donna</p> <p>Choco pips (5) ● (E) Edward</p> <p>Honey footballs (6) ● (F) Fiona</p>	B1	[1]	Incomplete matching correct	Condone any extra labels (working) but not extra arcs (working), apart from an X if used Alternating path shown (even if dashed) ⇒ B0	
	(iii)	<p>$6 = B - 3 = D - 2 = C - 5 = A$</p> <p>Cornflakes = Fiona</p> <p>Rice pips = Charlie</p> <p>Wheat biscuits = Donna</p> <p>Oatie bits = Edward</p> <p>Choco pips = Adam</p> <p>Honey footballs = Barbara</p>	B1	B1	[2]	This alternating path written down, not just read off from labels on graph This matching written down in words (or numbers and letters)	Written in any unambiguous form (condone reversed) Written in any unambiguous form A = Choco pips (5) B = Honey footballs (6) C = Rice pips (2) D = Wheat biscuits (3) E = Oatie bits (4) F = Cornflakes (1)
	(iv)	<p>$A = 1 - F = 4 - E = 5$</p> <p>Cornflakes = Adam</p> <p>Rice pips = Charlie</p> <p>Wheat biscuits = Donna</p> <p>Oatie bits = Fiona</p> <p>Choco pips = Edward</p> <p>Honey footballs = Barbara</p>	B1	B1	[2]	This alternating path written down, not just read off from labels on graph This matching written down in words (or numbers and letters)	Written in any unambiguous form Not a longer path Written in any unambiguous form A = Cornflakes (1) B = Honey footballs (6) C = Rice pips (2) D = Wheat biscuits (3) E = Choco pips (5) F = Oatie bits (4)

2	(i)	<p>Dummy columns are needed to make a square table</p> <p>Dummies should not have positive scores because they should not be more suitable than any of the family members</p> <p>Modify resulting table by subtracting all scores from 8 (or any fixed constant ≥ 8)</p>	<p>B1</p> <p>B1</p> <p>B1</p>	[3]	<p>Square Because there are more cards than people</p> <p>Smallest value in table is 0 Less than or equal to all values in table So they do not affect the row reductions</p> <p>Saying how to convert to a minimisation problem</p>	<p>So that (number of) people equals (number of) cards; one person for each card (or vv)</p> <p>Not 'dummies are not suitable for anyone' (dummies are people not cards) Not vague statements</p> <p>Must be written down, not just shown in working</p>																																																																																																																																																																
	(ii)	<p>Add dummy columns and convert to a minimisation problem</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th></th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>6</td> <td>4</td> <td>6</td> <td>2</td> <td>8</td> <td>4</td> <td>8</td> <td>8</td> </tr> <tr> <td>Q</td> <td>5</td> <td>3</td> <td>5</td> <td>3</td> <td>5</td> <td>4</td> <td>8</td> <td>8</td> </tr> <tr> <td>R</td> <td>2</td> <td>1</td> <td>2</td> <td>2</td> <td>2</td> <td>0</td> <td>8</td> <td>8</td> </tr> <tr> <td>S</td> <td>4</td> <td>2</td> <td>4</td> <td>4</td> <td>8</td> <td>4</td> <td>8</td> <td>8</td> </tr> <tr> <td>T</td> <td>7</td> <td>8</td> <td>7</td> <td>4</td> <td>8</td> <td>3</td> <td>8</td> <td>8</td> </tr> <tr> <td>U</td> <td>5</td> <td>4</td> <td>4</td> <td>4</td> <td>5</td> <td>5</td> <td>8</td> <td>8</td> </tr> <tr> <td>V</td> <td>1</td> <td>3</td> <td>1</td> <td>2</td> <td>1</td> <td>3</td> <td>8</td> <td>8</td> </tr> <tr> <td>W</td> <td>4</td> <td>2</td> <td>3</td> <td>4</td> <td>3</td> <td>3</td> <td>8</td> <td>8</td> </tr> </tbody> </table> <p>Reduce rows</p> <table border="1" style="margin-left: 20px;"> <thead> <tr> <th></th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>4</td> <td>2</td> <td>4</td> <td>0</td> <td>6</td> <td>2</td> <td>6</td> <td>6</td> </tr> <tr> <td>Q</td> <td>2</td> <td>0</td> <td>2</td> <td>0</td> <td>2</td> <td>1</td> <td>5</td> <td>5</td> </tr> <tr> <td>R</td> <td>2</td> <td>1</td> <td>2</td> <td>2</td> <td>2</td> <td>0</td> <td>8</td> <td>8</td> </tr> <tr> <td>S</td> <td>2</td> <td>0</td> <td>2</td> <td>2</td> <td>6</td> <td>2</td> <td>6</td> <td>6</td> </tr> <tr> <td>T</td> <td>4</td> <td>5</td> <td>4</td> <td>1</td> <td>5</td> <td>0</td> <td>5</td> <td>5</td> </tr> <tr> <td>U</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>4</td> <td>4</td> </tr> <tr> <td>V</td> <td>0</td> <td>2</td> <td>0</td> <td>1</td> <td>0</td> <td>2</td> <td>7</td> <td>7</td> </tr> <tr> <td>W</td> <td>2</td> <td>0</td> <td>1</td> <td>2</td> <td>1</td> <td>1</td> <td>6</td> <td>6</td> </tr> </tbody> </table>		A	B	C	D	E	F	G	H	P	6	4	6	2	8	4	8	8	Q	5	3	5	3	5	4	8	8	R	2	1	2	2	2	0	8	8	S	4	2	4	4	8	4	8	8	T	7	8	7	4	8	3	8	8	U	5	4	4	4	5	5	8	8	V	1	3	1	2	1	3	8	8	W	4	2	3	4	3	3	8	8		A	B	C	D	E	F	G	H	P	4	2	4	0	6	2	6	6	Q	2	0	2	0	2	1	5	5	R	2	1	2	2	2	0	8	8	S	2	0	2	2	6	2	6	6	T	4	5	4	1	5	0	5	5	U	1	0	0	0	1	1	4	4	V	0	2	0	1	0	2	7	7	W	2	0	1	2	1	1	6	6	<p>M1</p> <p>M1</p>	<p>This matrix seen or implied</p> <p>Substantially correct attempt at reducing (their) rows (or columns)</p>
	A	B	C	D	E	F	G	H																																																																																																																																																														
P	6	4	6	2	8	4	8	8																																																																																																																																																														
Q	5	3	5	3	5	4	8	8																																																																																																																																																														
R	2	1	2	2	2	0	8	8																																																																																																																																																														
S	4	2	4	4	8	4	8	8																																																																																																																																																														
T	7	8	7	4	8	3	8	8																																																																																																																																																														
U	5	4	4	4	5	5	8	8																																																																																																																																																														
V	1	3	1	2	1	3	8	8																																																																																																																																																														
W	4	2	3	4	3	3	8	8																																																																																																																																																														
	A	B	C	D	E	F	G	H																																																																																																																																																														
P	4	2	4	0	6	2	6	6																																																																																																																																																														
Q	2	0	2	0	2	1	5	5																																																																																																																																																														
R	2	1	2	2	2	0	8	8																																																																																																																																																														
S	2	0	2	2	6	2	6	6																																																																																																																																																														
T	4	5	4	1	5	0	5	5																																																																																																																																																														
U	1	0	0	0	1	1	4	4																																																																																																																																																														
V	0	2	0	1	0	2	7	7																																																																																																																																																														
W	2	0	1	2	1	1	6	6																																																																																																																																																														

	<p>Reduce columns</p> <table border="1"> <thead> <tr> <th></th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>4</td> <td>2</td> <td>4</td> <td>0</td> <td>6</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>Q</td> <td>2</td> <td>0</td> <td>2</td> <td>0</td> <td>2</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>R</td> <td>2</td> <td>1</td> <td>2</td> <td>2</td> <td>2</td> <td>0</td> <td>4</td> <td>4</td> </tr> <tr> <td>S</td> <td>2</td> <td>0</td> <td>2</td> <td>2</td> <td>6</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>T</td> <td>4</td> <td>5</td> <td>4</td> <td>1</td> <td>5</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>U</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>V</td> <td>0</td> <td>2</td> <td>0</td> <td>1</td> <td>0</td> <td>2</td> <td>3</td> <td>3</td> </tr> <tr> <td>W</td> <td>2</td> <td>0</td> <td>1</td> <td>2</td> <td>1</td> <td>1</td> <td>2</td> <td>2</td> </tr> </tbody> </table>		A	B	C	D	E	F	G	H	P	4	2	4	0	6	2	2	2	Q	2	0	2	0	2	1	1	1	R	2	1	2	2	2	0	4	4	S	2	0	2	2	6	2	2	2	T	4	5	4	1	5	0	1	1	U	1	0	0	0	1	1	0	0	V	0	2	0	1	0	2	3	3	W	2	0	1	2	1	1	2	2	<p>A1</p>	<p>[3]</p>	<p>Reducing columns for a correct row reduced matrix to achieve this (given) reduced cost matrix</p>	<p>Correct method, with no errors leading to the given matrix</p> <p>Could get away with reducing rows correctly and then saying that reducing columns gives the matrix in the question</p>																																																																																	
	A	B	C	D	E	F	G	H																																																																																																																																																															
P	4	2	4	0	6	2	2	2																																																																																																																																																															
Q	2	0	2	0	2	1	1	1																																																																																																																																																															
R	2	1	2	2	2	0	4	4																																																																																																																																																															
S	2	0	2	2	6	2	2	2																																																																																																																																																															
T	4	5	4	1	5	0	1	1																																																																																																																																																															
U	1	0	0	0	1	1	0	0																																																																																																																																																															
V	0	2	0	1	0	2	3	3																																																																																																																																																															
W	2	0	1	2	1	1	2	2																																																																																																																																																															
<p>(iii)</p>	<p>Cross out 0's using 5 lines</p> <table border="1"> <thead> <tr> <th></th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>4</td> <td>2</td> <td>4</td> <td>0</td> <td>6</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>Q</td> <td>2</td> <td>0</td> <td>2</td> <td>0</td> <td>2</td> <td>1</td> <td>1</td> <td>1</td> </tr> <tr> <td>R</td> <td>2</td> <td>1</td> <td>2</td> <td>2</td> <td>2</td> <td>0</td> <td>4</td> <td>4</td> </tr> <tr> <td>S</td> <td>2</td> <td>0</td> <td>2</td> <td>2</td> <td>6</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>T</td> <td>4</td> <td>5</td> <td>4</td> <td>1</td> <td>5</td> <td>0</td> <td>1</td> <td>1</td> </tr> <tr> <td>U</td> <td>1</td> <td>0</td> <td>0</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>V</td> <td>0</td> <td>2</td> <td>0</td> <td>1</td> <td>0</td> <td>2</td> <td>3</td> <td>3</td> </tr> <tr> <td>W</td> <td>2</td> <td>0</td> <td>1</td> <td>2</td> <td>1</td> <td>1</td> <td>2</td> <td>2</td> </tr> </tbody> </table> <p>Augment</p> <table border="1"> <thead> <tr> <th></th> <th>A</th> <th>B</th> <th>C</th> <th>D</th> <th>E</th> <th>F</th> <th>G</th> <th>H</th> </tr> </thead> <tbody> <tr> <td>P</td> <td>3</td> <td>2</td> <td>3</td> <td>0</td> <td>5</td> <td>2</td> <td>1</td> <td>1</td> </tr> <tr> <td>Q</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> <td>0</td> <td>0</td> </tr> <tr> <td>R</td> <td>1</td> <td>1</td> <td>1</td> <td>2</td> <td>1</td> <td>0</td> <td>3</td> <td>3</td> </tr> <tr> <td>S</td> <td>1</td> <td>0</td> <td>1</td> <td>2</td> <td>5</td> <td>2</td> <td>1</td> <td>1</td> </tr> <tr> <td>T</td> <td>3</td> <td>5</td> <td>3</td> <td>1</td> <td>4</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>U</td> <td>1</td> <td>1</td> <td>0</td> <td>1</td> <td>1</td> <td>2</td> <td>0</td> <td>0</td> </tr> <tr> <td>V</td> <td>0</td> <td>3</td> <td>0</td> <td>2</td> <td>0</td> <td>3</td> <td>3</td> <td>3</td> </tr> <tr> <td>W</td> <td>1</td> <td>0</td> <td>0</td> <td>2</td> <td>0</td> <td>1</td> <td>1</td> <td>1</td> </tr> </tbody> </table> <p>'View from air' is sent to Adam 'Scenic view' is sent to Barbara 'University' is sent to Charlie 'Painted barges' is sent to Donna 'Windmills' is sent to Edward 'Reichsmuseum' is sent to Fiona 'Quaint houses' and 'Tulips' are not used</p>		A	B	C	D	E	F	G	H	P	4	2	4	0	6	2	2	2	Q	2	0	2	0	2	1	1	1	R	2	1	2	2	2	0	4	4	S	2	0	2	2	6	2	2	2	T	4	5	4	1	5	0	1	1	U	1	0	0	0	1	1	0	0	V	0	2	0	1	0	2	3	3	W	2	0	1	2	1	1	2	2		A	B	C	D	E	F	G	H	P	3	2	3	0	5	2	1	1	Q	1	0	1	0	1	1	0	0	R	1	1	1	2	1	0	3	3	S	1	0	1	2	5	2	1	1	T	3	5	3	1	4	0	0	0	U	1	1	0	1	1	2	0	0	V	0	3	0	2	0	3	3	3	W	1	0	0	2	0	1	1	1	<p>M1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>B1</p>	<p>[6]</p>	<p>This is not follow through from (ii)</p> <p>Cross out 0's using these 5 lines</p> <p>Substantially correct attempt at augmenting (from 5 lines crossed out, or more)</p> <p>This final matrix (cao)</p> <p>A valid matching from the 0's in their 8x8 reduced cost matrix</p> <p>This matching, in words or symbols</p> <p>Q and T not used</p>	<p>May be seen in answer space for (ii), allow this if it happens, but check here first</p> <p>All entries correct</p> <p>Matching the six cards using their entries with reduced cost = 0 from an 8x8 matrix</p> <p>cao</p> <p>cao</p>
	A	B	C	D	E	F	G	H																																																																																																																																																															
P	4	2	4	0	6	2	2	2																																																																																																																																																															
Q	2	0	2	0	2	1	1	1																																																																																																																																																															
R	2	1	2	2	2	0	4	4																																																																																																																																																															
S	2	0	2	2	6	2	2	2																																																																																																																																																															
T	4	5	4	1	5	0	1	1																																																																																																																																																															
U	1	0	0	0	1	1	0	0																																																																																																																																																															
V	0	2	0	1	0	2	3	3																																																																																																																																																															
W	2	0	1	2	1	1	2	2																																																																																																																																																															
	A	B	C	D	E	F	G	H																																																																																																																																																															
P	3	2	3	0	5	2	1	1																																																																																																																																																															
Q	1	0	1	0	1	1	0	0																																																																																																																																																															
R	1	1	1	2	1	0	3	3																																																																																																																																																															
S	1	0	1	2	5	2	1	1																																																																																																																																																															
T	3	5	3	1	4	0	0	0																																																																																																																																																															
U	1	1	0	1	1	2	0	0																																																																																																																																																															
V	0	3	0	2	0	3	3	3																																																																																																																																																															
W	1	0	0	2	0	1	1	1																																																																																																																																																															

3	(i)	<p>If it is rainy $D > A > C > B$ but if it is sunny $B > C > A > D$</p> <p>so for each pair the better choice for rainy weather is the worse choice for sunny weather</p>	M1		A substantially correct explanation for at least one pair in words or using inequalities	'B is best for sunny but worst for rainy'; 'no magazine gives a higher income for both sunny and rainy weather over <u>any other</u> magazine'																				
			A1	[2]	A correct explanation for all pairs: A&B, A&C, A&D, B&C, B&D, C&D or equivalent (eg why each cannot always be best)	Explaining how what they have done shows that no magazine can be rejected by dominance																				
	(ii)	<table border="1" style="display: inline-table; vertical-align: middle;"> <tr> <td></td> <td>R</td> <td>S</td> <td>row min</td> </tr> <tr> <td>A</td> <td>4000</td> <td>5000</td> <td>4000</td> </tr> <tr> <td>B</td> <td>1000</td> <td>7000</td> <td>1000</td> </tr> <tr> <td>C</td> <td>3000</td> <td>6000</td> <td>3000</td> </tr> <tr> <td>D</td> <td>5000</td> <td>3000</td> <td>3000</td> </tr> </table> <p>col max 5000 7000</p> <p>Play-safe is 'Activity holidays'</p> <p>Play-safe for weather is 'rainy' = 5000</p> <p>4000 \neq 5000 so unstable</p>		R	S	row min	A	4000	5000	4000	B	1000	7000	1000	C	3000	6000	3000	D	5000	3000	3000	M1		Calculating row minima (condone 1 error) (or maximin)	4000, 1000, 3000, 3000 (or 4, 1, 3, 3)
		R	S	row min																						
A	4000	5000	4000																							
B	1000	7000	1000																							
C	3000	6000	3000																							
D	5000	3000	3000																							
			A1		A (cao, without wrong working)	(May also see R)																				
			M1		Calculating column minimax or substantially correct reasoned argument	If Basil chooses A(plays safe) and it is rainy he would have been better with D (or if it is sunny he would have been better with B or with C)																				
			A1	[4]	Hence showing that game is unstable (may be reasoned in words)	He would want to change from his play-safe strategy, so game is unstable																				
(iii)	<p>A: $(0.4)(4000)+(0.6)(5000) = \text{£}4600$ B: $(0.4)(1000)+(0.6)(7000) = \text{£}4600$ C: $(0.4)(3000)+(0.6)(6000) = \text{£}4800$ D: $(0.4)(5000)+(0.6)(3000) = \text{£}3800$</p>	M1		Correct method for any one magazine	Any one calculation seen correctly or any one final value correct																					
			A1	[2]	All four correct	4600 4600 4800 3800 (need not have £)																				
(iv)	<p>British beaches Dining experiences</p>	B1	[1]	$p = 0$ (sunny) \Rightarrow B $p = 1$ (rainy) \Rightarrow D	cao																					

4	(i)		M1 M1dep A1	[3]	<p>Durations not necessary</p> <p>Correct structure, even without directions shown Activities (letters) must be labelled</p> <p>Exactly four directed dummies used correctly</p> <p>Completely correct, with exactly four dummies used and all arcs directed</p>	<p>Activity on node scores 0</p> <p>Precedences must be correct, other than possibly due to any unmarked directions</p> <p>Dummies may appear before or after <i>B, H, J</i> Dummy attached to <i>B</i> could alternatively be attached to <i>A</i> (before or after)</p> <p>With single start and finish</p>
	(ii)	<p>Minimum project completion time = 13 hours Critical activities: <i>A, C, F, G, H</i></p>	M1 M1 A1ft B1 B1	[5]	<p>Follow through their activity network if possible</p> <p>Substantially correct attempt at forward pass</p> <p>Substantially correct attempt at backward pass</p> <p>Both passes wholly correct</p> <p>13 cao <i>A C F G H</i> cao (in any order) and no extras</p>	<p>No more than two independent errors or omissions</p> <p>No more than two independent errors or omissions</p> <p>Follow through if possible</p> <p>Condone wrong units</p>
	(iii)	<p>Workers</p>	M1 A1	[2]	<p>Axes scaled appropriately and a plausible histogram with no holes or overhangs</p> <p>Axes also labelled and histogram completely correct, cao</p>	<p>At least as far as 10 on time axis (horizontal) and first hour at height 5 workers</p> <p>Values and appropriate label on each axis, shape correct</p>
	(iv)	Delay <i>D</i> by 1 hour, so that it starts after <i>B</i> has finished and does not delay any other activity.	B1	[1]	<p>Delay <i>D</i> by 1 hour (or 2)</p>	<p>Start <i>D</i> after 1 hour (or 2) BOD 'start <i>D</i> at 2' (or 3)</p>
	(v)	Both do <i>A</i> then <i>B</i> (or <i>B</i> then <i>A</i>) immediately followed by <i>C</i> ; then one does <i>D</i> while other does <i>F</i> ; then both do <i>E</i> followed by <i>G</i> ; finally one does <i>H</i> and other does <i>I</i> and <i>J</i> 16 hours	M1 A1 B1	[3]	<p>A reasonable attempt to describe a valid schedule</p> <p>A correct schedule described unambiguously May be given as a timetable 16 cao</p>	<p>A schedule that never needs more than two workers and that begins with <i>A, B</i> or <i>B, A</i> immediately followed by <i>C</i> Accept, for example, <i>A B C D E G H</i> <i>F I J</i></p>

For reference:

Activity	Duration (hours)	Immediate predecessors	Number of workers
<i>A</i> : Choose summerhouse	2	-	2
<i>B</i> : Buy slabs for base	1	-	2
<i>C</i> : Take goods home	2	<i>A, B</i>	2
<i>D</i> : Level ground	3	-	1
<i>E</i> : Lay slabs	2	<i>C, D</i>	2
<i>F</i> : Treat wood	3	<i>C</i>	1
<i>G</i> : Make floor, walls and roof	4	<i>E, F</i>	2
<i>H</i> : Fit windows and door	2	<i>G</i>	1
<i>I</i> : Fit patio rail	1	<i>G</i>	1
<i>J</i> : Fit shelving	1	<i>G</i>	1

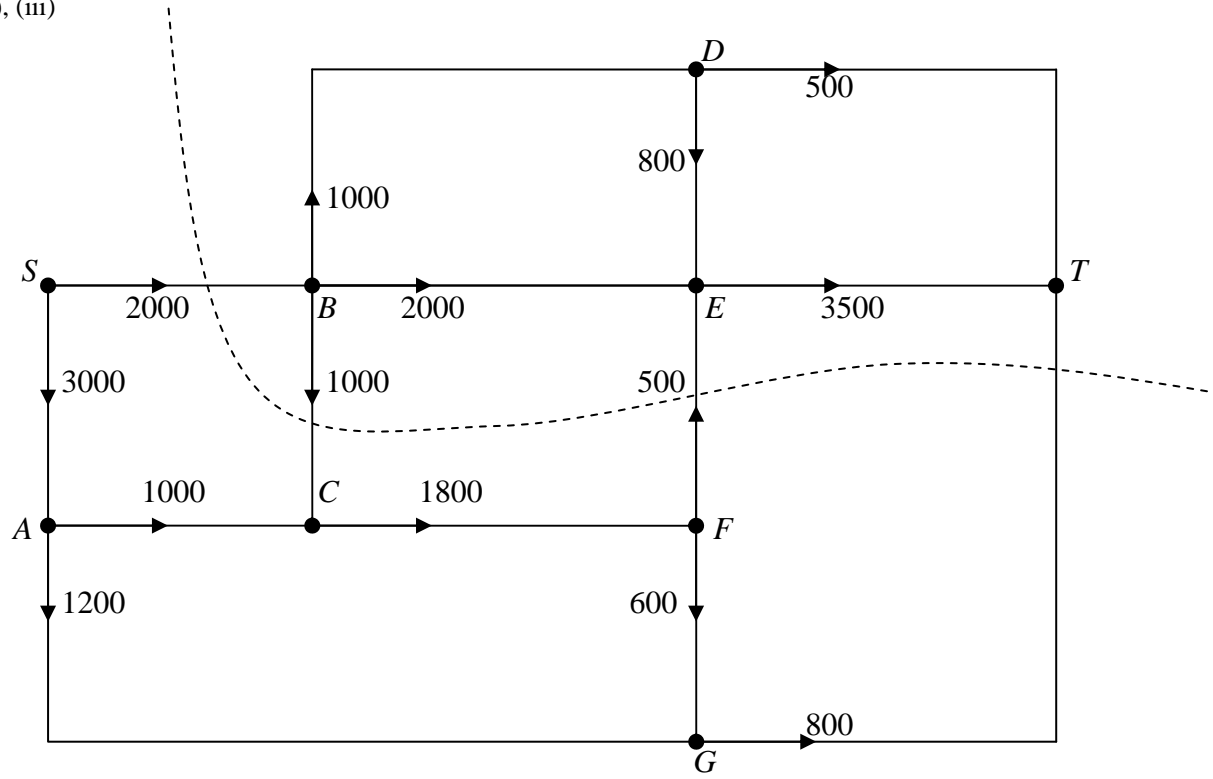
Part (v)

Activity	Start time
<i>A</i> : Choose summerhouse	0
<i>B</i> : Buy slabs for base	2
<i>C</i> : Take goods home	3
<i>D</i> : Level ground	5
<i>E</i> : Lay slabs	8
<i>F</i> : Treat wood	5
<i>G</i> : Make floor, walls and roof	10
<i>H</i> : Fit windows and door	14
<i>I</i> : Fit patio rail	14
<i>J</i> : Fit shelving	15

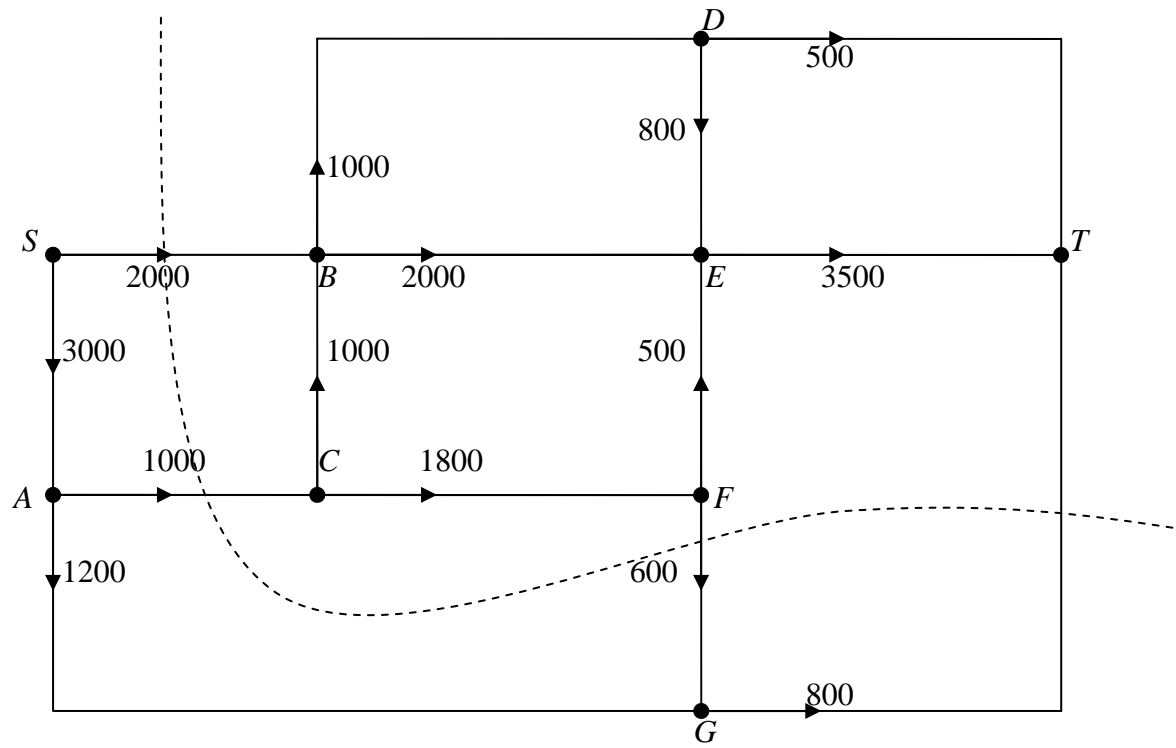
I and J may be interchanged

5	(i)	2000 + 0 + 1800 + 0 + 800 = 4600	M1 A1	[2]	2000+1800+800, no backflow 4600 cao	For method: condone <u>one</u> error or omission, if working is seen
	(ii)	SA ... because at most 2200 can leave A	B1		Valid explanation of why SA < 3000	AC+AG = 1000+1200, calc not req ^d (could have eg AG ≤ 800 so AC+AG ≤ 1800) DE+BE+FE = 800+2000+500, calc not req ^d (eg BE+BD ≤ 2000 so into E ≤ 2500) AC+BC = 1000+1000 but CF = 1800
		ET ... because at most 3300 can enter E	B1		Valid explanation of why ET < 3500	
		AC and BC ... because at most 1800 can leave C	B1	[3]	Valid explanation of why AC+BC < 2000	
	(iii)	eg 	M1 A1		Assume blanks are zero flow A flow of 3300 from S to T No arc capacities are exceeded	May list flows 3300 out of S, 3300 into T and flow in = flow out at A, B, C, D, E, F, G Not labelling procedure Or shown on diagram If multiple answers given mark written work rather than diagram
	(iv)	Arrows in original direction of flow show excess capacities equal to arc capacities Arrows opposing original direction of flow show potential backflows equal to 0	B1 B1	[2]	Not reversed Values must be visible	Working will all be on one diagram, try to interpret the intention of the candidate
		Arrows SB, BE, ET decreased by 2000 Arrows TE, EB, BS increased by 2000	B1 B1	[2]	Decreasing their excess capacities SBET by 2000 Increasing their potential backflows SBET by 2000	Values must be visible. Follow through their labelling if possible
	(vi)	eg SACBDT flow 500 SACBDET flow 500 SAGT flow 800	M1 A1		Listing any valid flow augmentation from S to T (route and flow), apart from SBET Valid routes that saturate AC and GT	Valid routes with AC = 1000 and GT = 800
New excess capacities and potential backflows Maximum flow = 3800		B1 B1	[4]	Values updated on diagram appropriately 3800 stated (cao)	Flow must be 3800 3800 must be written in this part	
(vii)	Showing a valid flow of 3800 Cut {S, A, G}, {B, C, D, E, F, T} = 3800 Max flow = min cut, we have a flow of 3800 and a cut of 3800 so this is the max flow	B1 M1 A1	[3]	Follow through their potential backflows if possible, or a fresh start Identifying this cut in any way (or in words) Explaining how this shows that 3800 is max flow	May need to check back to (vi) (follow through may not lead to 3800) Cut may be marked on diagram Need a flow of 3800 seen or described correctly	

For reference:
Parts (i), (ii), (iii)



For reference:
Parts (iv), (v), (vi), (vii)



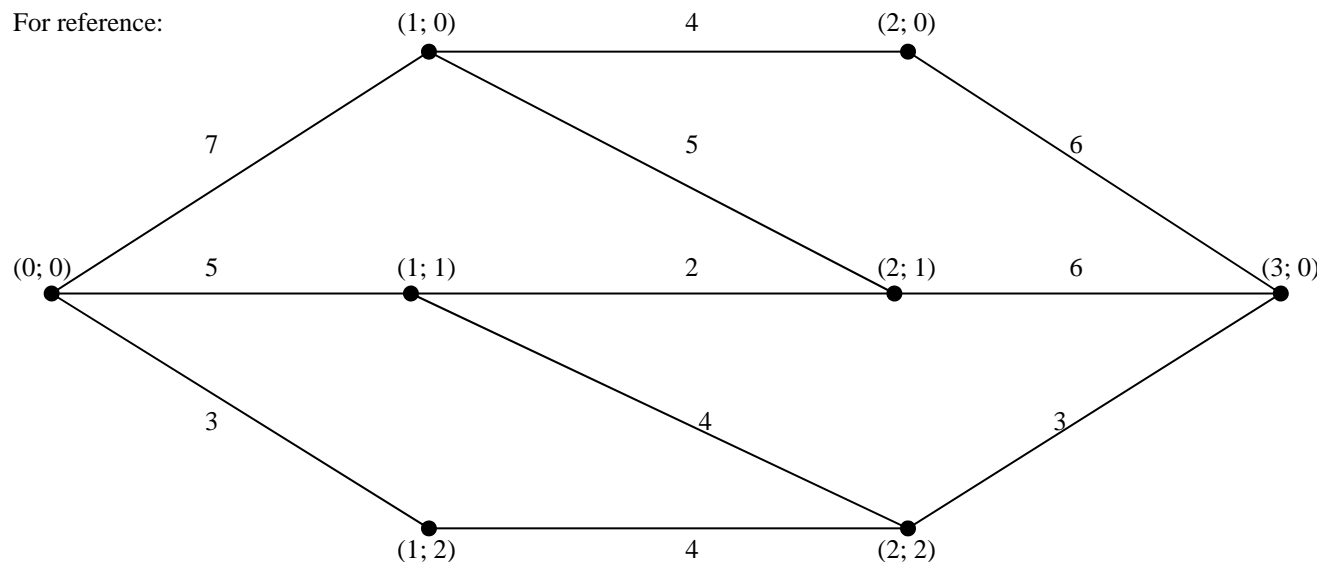
4737

Mark Scheme

June 2011

6	<table border="1"> <thead> <tr> <th>Stage</th> <th>State</th> <th>Action</th> <th>Working</th> <th>Suboptimal maximin</th> </tr> </thead> <tbody> <tr> <td rowspan="3">2</td> <td>0</td> <td>0</td> <td>6</td> <td>6</td> </tr> <tr> <td>1</td> <td>0</td> <td>6</td> <td>6</td> </tr> <tr> <td>2</td> <td>0</td> <td>3</td> <td>3</td> </tr> <tr> <td rowspan="5">1</td> <td rowspan="2">0</td> <td>0</td> <td>$\min(4,6)=4$</td> <td rowspan="2">5</td> </tr> <tr> <td>1</td> <td>$\min(5,6)=5$</td> </tr> <tr> <td rowspan="3">1</td> <td>1</td> <td>$\min(2,6)=2$</td> <td rowspan="3">3</td> </tr> <tr> <td>2</td> <td>$\min(4,3)=3$</td> </tr> <tr> <td>2</td> <td>$\min(4,3)=3$</td> </tr> <tr> <td rowspan="3">0</td> <td rowspan="3">0</td> <td>0</td> <td>$\min(7,5)=5$</td> <td rowspan="3">5</td> </tr> <tr> <td>1</td> <td>$\min(5,3)=3$</td> </tr> <tr> <td>2</td> <td>$\min(3,3)=3$</td> </tr> </tbody> </table>	Stage	State	Action	Working	Suboptimal maximin	2	0	0	6	6	1	0	6	6	2	0	3	3	1	0	0	$\min(4,6)=4$	5	1	$\min(5,6)=5$	1	1	$\min(2,6)=2$	3	2	$\min(4,3)=3$	2	$\min(4,3)=3$	0	0	0	$\min(7,5)=5$	5	1	$\min(5,3)=3$	2	$\min(3,3)=3$	<p>B1 B1 M1</p> <p>A1 [4]</p> <hr/> <p>M1</p> <p>A1</p> <p>M1 A1</p> <p>B1</p>	<p>Structure of table correct Actions labelled correctly Stages labelled correctly, working backwards from stage 2 States labelled correctly</p> <p>[4]</p> <hr/> <p>Working values correct for stage 1 (4, 5, 2, 3, 3) Suboptimal maximin values correct for stage 1</p> <p>Follow through if possible from stage 1 Working values correct for stage 0 (5, 3, 3) Suboptimal maximin value correct for stage 0</p> <p>cao</p> <p>[5]</p>	<p>Stage, state, action and ≥ 1 other column Condone working forwards for B mark Not (stage; state), must be working backwards Not (stage; state)</p> <hr/> <p>If working forwards penalise the A marks and use diagram to deduce values Must be solving maximin problem</p> <p>Follow through if possible from their previous stage Must be solving a maximin problem</p> <p>May be given in reverse Accept with (0; 0) and/or (3; 0) missing Accept 0-0-1-0 but only with all four states and in this order, in this case</p>
	Stage	State	Action	Working	Suboptimal maximin																																									
2	0	0	6	6																																										
	1	0	6	6																																										
	2	0	3	3																																										
1	0	0	$\min(4,6)=4$	5																																										
		1	$\min(5,6)=5$																																											
	1	1	$\min(2,6)=2$	3																																										
		2	$\min(4,3)=3$																																											
		2	$\min(4,3)=3$																																											
0	0	0	$\min(7,5)=5$	5																																										
		1	$\min(5,3)=3$																																											
		2	$\min(3,3)=3$																																											
<p>Route: (0; 0) – (1; 0) – (2; 1) – (3; 0)</p>																																														

For reference:



OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

