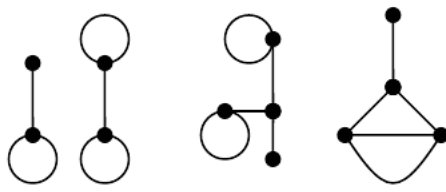
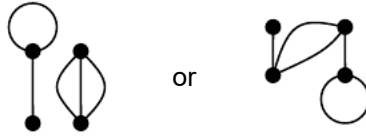


Mark Scheme 4736

June 2006

1	(i)	2 4 3 3 2 5 4 Box 1 2 4 2 Box 2 3 3 Box 3 5 Box 4 4	M1 A1 [2]	For packing these seven weights into boxes with no more than 8 kg total in each box For this packing
	(ii)	5 4 4 3 3 2 2 Box 1 5 3 Box 2 4 4 Box 3 3 2 2	B1 M1 A1 [3]	For putting the weights into decreasing order (may be implied from packing) For packing the seven weights into three boxes with no more than 8 kg total in each box For this packing
	(iii)	15×2^2 = 60 seconds	M1 A1 [2]	For a correct calculation For 60 or 60 seconds or 1 minute 7
2	(i)	 <p>graph A graph B graph C</p> <p>other solutions:</p> 	M1 A1 [2] ----- M1 A1 [2] ----- M1 A1 [2]	Graphs may be in any order For a reasonable attempt For a graph that is topologically equivalent to one of these graphs For a different reasonable attempt For a graph that is topologically equivalent to one of these graphs For another different reasonable attempt For a graph that is topologically equivalent to one of these graphs
	(ii)	The graphs each have four odd nodes, but Eulerian graphs have no odd nodes.	B1 [1]	For any recognition that the nodes are not all even 7

3	(i)	Travelling salesperson	B1 [1]	Identifying TSP by name
	(ii)	<p>A – B – E – G – F – D – C – A</p> <p>130 (minutes)</p> <p>Shortest possible time \leq 130 minutes</p>	<p>M1</p> <p>A1</p> <p>B1</p> <p>B1 [4]</p>	<p>For starting with A – B – E – G - ...</p> <p>For this closed tour</p> <p>For 130</p> <p>For less than or equal to their time, with units</p>
	(iii)	<p>Order of connecting: B, E, G, F, D, C</p> <p>Lower bound = 10 + 15 + 95 = 120 minutes</p>	<p>B1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>M1</p> <p>A1 [6]</p>	<p>For a valid vertex order (or arc order) for their starting point</p> <p>For a diagram or listing showing a tree connecting the vertices B, C, D, E, F and G but not A</p> <p>For a diagram showing one of these trees (vertices must be labelled but arc weights are not needed)</p> <p>For stating or using the total weight of their tree</p> <p>For stating or using AB and AD or 10 + 15</p> <p>For 120 or calculating 25 + their 95, with units</p>
	(iv)	<p>A – B – E – G – F – C – D – A</p> <p>or this in reverse</p>	<p>M1</p> <p>A1 [2]</p>	<p>For a reasonable attempt</p> <p>For a valid tour of weight 125</p>

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4	(i)	$x \leq 2$ $y \geq 1$ $y \leq 2x$ $x + y \leq 4$	B1 B1 B1 B1 [4]	Strict inequalities used, penalise first time only All inequalities reversed, penalise first time only															
	(ii)	$(2, 1), (2, 2)$ $(\frac{1}{2}, 1)$ $(1\frac{1}{3}, 2\frac{2}{3})$	B1 B1 B1 [3]	Both of these This vertex in any exact form This vertex in any exact form or correct to 3 sf															
	(iii)	<table style="border-collapse: collapse; margin-bottom: 10px;"> <tr> <td style="padding-right: 10px;">x</td> <td style="padding-right: 10px;">y</td> <td>$P = x + 2y$</td> </tr> <tr> <td>2</td> <td>1</td> <td>4</td> </tr> <tr> <td>2</td> <td>2</td> <td>6</td> </tr> <tr> <td>$\frac{1}{2}$</td> <td>1</td> <td>$2\frac{1}{2}$</td> </tr> <tr> <td>$1\frac{1}{3}$</td> <td>$2\frac{2}{3}$</td> <td>$6\frac{2}{3}$</td> </tr> </table> $x = 1\frac{1}{3}, y = 2\frac{2}{3}$ (may be given in coordinate form) $P = 6\frac{2}{3}$	x	y	$P = x + 2y$	2	1	4	2	2	6	$\frac{1}{2}$	1	$2\frac{1}{2}$	$1\frac{1}{3}$	$2\frac{2}{3}$	$6\frac{2}{3}$	M1 A1 A1 [3]	Evidence of checking value at any vertex or using a sliding profit line Their x and y values at maximum in any exact form or correct to 3 sf Their maximum P value in any exact form or correct to 3 sf
	x	y	$P = x + 2y$																
	2	1	4																
2	2	6																	
$\frac{1}{2}$	1	$2\frac{1}{2}$																	
$1\frac{1}{3}$	$2\frac{2}{3}$	$6\frac{2}{3}$																	
(iv)	<table style="border-collapse: collapse; margin-bottom: 10px;"> <tr> <td style="padding-right: 10px;">x</td> <td style="padding-right: 10px;">y</td> <td>$Q = 2x - y$</td> </tr> <tr> <td>2</td> <td>1</td> <td>3</td> </tr> <tr> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <td>$\frac{1}{2}$</td> <td>1</td> <td>0</td> </tr> <tr> <td>$1\frac{1}{3}$</td> <td>$2\frac{2}{3}$</td> <td>0</td> </tr> </table> $Q = 0$ (x, y) can be any point on the line segment joining $(\frac{1}{2}, 1)$ and $(1\frac{1}{3}, 2\frac{2}{3})$	x	y	$Q = 2x - y$	2	1	3	2	2	2	$\frac{1}{2}$	1	0	$1\frac{1}{3}$	$2\frac{2}{3}$	0	M1 A1 A1 [3]	Evidence of checking value at any vertex or using a sliding profit line 0 (cao) The edge of the feasible region where $y = 2x$ No follow through	
x	y	$Q = 2x - y$																	
2	1	3																	
2	2	2																	
$\frac{1}{2}$	1	0																	
$1\frac{1}{3}$	$2\frac{2}{3}$	0																	
(v)	$P = Q \Rightarrow 2x - y = x + 2y$ $\Rightarrow x = 3y$ $y = \frac{1}{3}x$ lies entirely in the shaded region	M1 A1 A1 [3]	For considering $P = Q$, or equivalent For this line, or any equivalent reasoning For explanation of why there are no solutions																

5	(i)	$2x - 5y + 2z + s = 10$ $2x + 3z + t = 30$	B1 [1]	Slack variables used correctly																												
	(ii)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <thead> <tr> <th><i>P</i></th> <th><i>x</i></th> <th><i>y</i></th> <th><i>z</i></th> <th><i>s</i></th> <th><i>t</i></th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>-1</td> <td>2</td> <td>3</td> <td>0</td> <td>0</td> <td>0</td> </tr> <tr> <td>0</td> <td>2</td> <td>-5</td> <td>2</td> <td>1</td> <td>0</td> <td>10</td> </tr> <tr> <td>0</td> <td>2</td> <td>0</td> <td>3</td> <td>0</td> <td>1</td> <td>30</td> </tr> </tbody> </table>	<i>P</i>	<i>x</i>	<i>y</i>	<i>z</i>	<i>s</i>	<i>t</i>		1	-1	2	3	0	0	0	0	2	-5	2	1	0	10	0	2	0	3	0	1	30	M1 A1 [2]	For overall structure correct, including two slack variable columns and column for RHS (condone omission of <i>P</i> column or labels) For a completely correct initial tableau, with no extra constraints added (condone variations in order of rows or columns)
	<i>P</i>	<i>x</i>	<i>y</i>	<i>z</i>	<i>s</i>	<i>t</i>																										
	1	-1	2	3	0	0	0																									
	0	2	-5	2	1	0	10																									
0	2	0	3	0	1	30																										
(iii)	Pivot on <i>x</i> column since it is the only column with a negative value in the objective row $10 \div 2 = 5$ $5 < 15$ so pivot on this row $30 \div 2 = 15$	B1 B1 [2]	For negative in objective row, top row, pay-off row, or equivalent For these two divisions shown																													
(iv)	New row 2 = row 2 \div 2 New row 1 = row 1 + new row 2 New row 3 = row 3 - 2 \times new row 2 <table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tbody> <tr> <td>1</td> <td>0</td> <td>-0.5</td> <td>4</td> <td>0.5</td> <td>0</td> <td>5</td> </tr> <tr> <td>0</td> <td>1</td> <td>-2.5</td> <td>1</td> <td>0.5</td> <td>0</td> <td>5</td> </tr> <tr> <td>0</td> <td>0</td> <td>5</td> <td>1</td> <td>-1</td> <td>1</td> <td>20</td> </tr> </tbody> </table>	1	0	-0.5	4	0.5	0	5	0	1	-2.5	1	0.5	0	5	0	0	5	1	-1	1	20	B1 B1 [2] M1 M1 A1 [3]	For dealing with the pivot row correctly For dealing with the other rows correctly May be coded by rows of table For updating their pivot row correctly For a reasonable attempt at updating other rows For correct values in tableau (condone consistent order of rows or columns). Do not follow through errors in initial tableau or pivot choice.								
1	0	-0.5	4	0.5	0	5																										
0	1	-2.5	1	0.5	0	5																										
0	0	5	1	-1	1	20																										
		$x = 5, y = 0, z = 0$ $P = 5$ Not the maximum feasible value of <i>P</i> since there is still a negative value in the objective row	B1 B1 B1 [3]	For reading off <i>x</i> , <i>y</i> and <i>z</i> from their tableau For reading off <i>P</i> from their tableau 'No' seen or implied and a correct reason																												

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6	(a)	<table border="1"> <tr><td>1</td><td>0</td></tr> <tr><td></td><td></td></tr> </table> <p>A</p>	1	0			<table border="1"> <tr><td>3</td><td>24</td></tr> <tr><td>24</td><td></td></tr> </table> <p>B</p>	3	24	24		<table border="1"> <tr><td>7</td><td>45</td></tr> <tr><td>45</td><td></td></tr> </table> <p>C</p>	7	45	45		M1	ANSWERED ON INSERT Values correct at B, D and E (condone temporary labels implied from permanent labels) Both 54 and 37 seen at H and both 51 and 47 seen at G (method)			
		1	0																		
3	24																				
24																					
7	45																				
45																					
<table border="1"> <tr><td>2</td><td>18</td></tr> <tr><td>18</td><td></td></tr> </table> <p>D</p>	2	18	18		<table border="1"> <tr><td>4</td><td>25</td></tr> <tr><td>25</td><td></td></tr> </table> <p>E</p>	4	25	25		<table border="1"> <tr><td>6</td><td>42</td></tr> <tr><td>42</td><td></td></tr> </table> <p>F</p>	6	42	42		<table border="1"> <tr><td>8</td><td>47</td></tr> <tr><td>51</td><td>47</td></tr> </table> <p>G</p>	8	47	51	47	A1	All temporary labels correct <u>and no extras</u>
2	18																				
18																					
4	25																				
25																					
6	42																				
42																					
8	47																				
51	47																				
<table border="1"> <tr><td>5</td><td>37</td></tr> <tr><td>54</td><td>37</td></tr> </table> <p>H</p>	5	37	54	37	<table border="1"> <tr><td>9</td><td>48</td></tr> <tr><td>48</td><td></td></tr> </table> <p>J</p>	9	48	48				B1	All permanent labels correct								
5	37																				
54	37																				
9	48																				
48																					
						B1	Order of labelling correct (condone boxes consistently swapped over)														
		A – E – H - J 48 metres		B1	For this route, including end vertices (cao)	B1 [7]	For 48 (cao)														
	(b)	A and J are the only odd nodes 48 + 300 = 348 metres		B1	Identifying odd nodes (or by implication)	M1	For their 48 + 300 (or their 300)														
	(i)	Odd nodes A, B, H, J AB = 24 AH = 37 AJ = 48 HJ = 11 BJ = 38 BH = 34 Repeat AB and HJ = 35 300 – 30 = 270 metres Shortest distance = 270 + 35 = 305 metres		A1 [3]	348 (cao)	B1	Identifying odd nodes (or by implication)														
	(ii)			B1	For distances from A – or from their Dijkstra	B1	For distances HJ, BJ, BH correct														
				M1	Choosing their least pairing or by implication	M1	Or by implication														
				A1 [6]	305 (cao)																
							16														