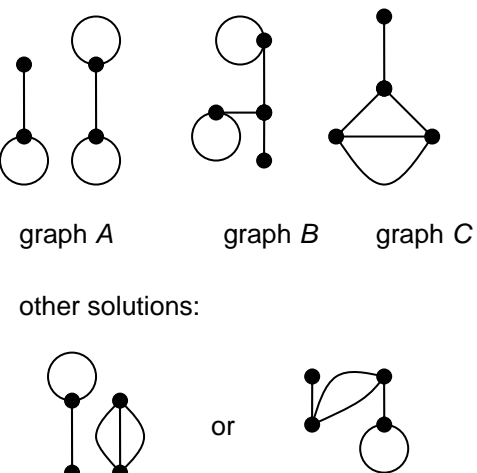


Mark Scheme 4736

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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	<p>(i) Travelling salesperson</p>	<p>B1 [1] Identifying TSP by name</p>
	<p>(ii) $A - B - E - G - F - D - C - A$</p> <p>130 (minutes) Shortest possible time ≤ 130 minutes</p>	<p>M1 For starting with $A - B - E - G - \dots$ A1 For this closed tour B1 For 130 B1 [4] For less than or equal to their time, with units</p>
	<p>(iii) Order of connecting: B, E, G, F, D, C</p> <p>Lower bound = $10 + 15 + 95$ = 120 minutes</p>	<p>B1 For a valid vertex order (or arc order) for their starting point</p> <p>M1 For a diagram or listing showing a tree connecting the vertices B, C, D, E, F and G but not A</p> <p>A1 For a diagram showing one of these trees (vertices must be labelled but arc weights are not needed)</p> <p>M1 M1 A1 [6] For stating or using the total weight of their tree For stating or using AB and AD or $10 + 15$ For 120 or calculating $25 +$ their 95, with units</p>
	<p>(iv) $A - B - E - G - F - C - D - A$ or this in reverse</p>	<p>M1 For a reasonable attempt A1 [2] For a valid tour of weight 125</p>
		13

5	(i)	$2x - 5y + 2z + s = 10$ $2x + 3z + t = 30$	B1 [1]	Slack variables used correctly																												
	(ii)	<table border="1" style="border-collapse: collapse; text-align: center;"> <tr> <td><i>P</i></td> <td><i>x</i></td> <td><i>y</i></td> <td><i>z</i></td> <td><i>s</i></td> <td><i>t</i></td> <td></td> </tr> <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> </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="border-collapse: collapse; text-align: center;"> <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> </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" style="display: inline-table; margin-right: 20px;"> <tr><td>1</td><td>0</td></tr> <tr><td> </td><td> </td></tr> </table> <p style="text-align: center;">A</p>	1	0			<table border="1" style="display: inline-table; margin-right: 20px;"> <tr><td>3</td><td>24</td></tr> <tr><td>24</td><td> </td></tr> </table> <p style="text-align: center;">B</p>	3	24	24		<table border="1" style="display: inline-table; margin-right: 20px;"> <tr><td>7</td><td>45</td></tr> <tr><td>45</td><td> </td></tr> </table> <p style="text-align: center;">C</p>	7	45	45		M1	<p>ANSWERED ON INSERT</p> <p>Values correct at B, D and E (condone temporary labels implied from permanent labels)</p> <p>Both 54 and 37 seen at H and both 51 and 47 seen at G (method)</p> <p>All temporary labels correct <u>and no extras</u></p> <p>All permanent labels correct</p> <p>Order of labelling correct (condone boxes consistently swapped over)</p> <p>For this route, including end vertices (cao) For 48 (cao)</p>		
		1	0																	
		3	24																	
24																				
7	45																			
45																				
<table border="1" style="display: inline-table; margin-right: 10px;"> <tr><td>2</td><td>18</td></tr> <tr><td>18</td><td> </td></tr> </table> <p style="text-align: center;">D</p>	2	18	18		<table border="1" style="display: inline-table; margin-right: 10px;"> <tr><td>4</td><td>25</td></tr> <tr><td>25</td><td> </td></tr> </table> <p style="text-align: center;">E</p>	4	25	25		<table border="1" style="display: inline-table; margin-right: 10px;"> <tr><td>6</td><td>42</td></tr> <tr><td>42</td><td> </td></tr> </table> <p style="text-align: center;">F</p>	6	42	42		<table border="1" style="display: inline-table; margin-right: 10px;"> <tr><td>8</td><td>47</td></tr> <tr><td>51</td><td>47</td></tr> </table> <p style="text-align: center;">G</p>	8	47	51	47	A1 B1 B1
2	18																			
18																				
4	25																			
25																				
6	42																			
42																				
8	47																			
51	47																			
<table border="1" style="display: inline-table; margin-right: 20px;"> <tr><td>5</td><td>37</td></tr> <tr><td>54</td><td>37</td></tr> </table> <p style="text-align: center;">H</p>	5	37	54	37	<table border="1" style="display: inline-table; margin-right: 20px;"> <tr><td>9</td><td>48</td></tr> <tr><td>48</td><td> </td></tr> </table> <p style="text-align: center;">J</p>	9	48	48		B1 B1 [7]										
5	37																			
54	37																			
9	48																			
48																				
<p>A – E – H – J 48 metres</p>		B1 B1 [7]																		
<p>(b) A and J are the only odd nodes 48 + 300 = 348 metres</p>		B1 M1 A1 [3]																		
<p>(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</p>		B1 B1 B1 M1 M1 A1 [6]																		
		16																		