

Mathematics

Advanced GCE

Unit **4737**: Decision Mathematics 2

Mark Scheme for January 2013

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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.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

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Annotations and abbreviations

Annotation in scoris	Meaning
✓ and ✗	
BOD	Benefit of doubt
FT	Follow through
ISW	Ignore subsequent working
M0, M1	Method mark awarded 0, 1
A0, A1	Accuracy mark awarded 0, 1
B0, B1	Independent mark awarded 0, 1
SC	Special case
^	Omission sign
MR	Misread
Highlighting	

Other abbreviations in mark scheme	Meaning
M1 dep*	Method mark dependent on a previous mark, indicated by *
cao	Correct answer only
oe	Or equivalent
rot	Rounded or truncated
soi	Seen or implied
www	Without wrong working

Subject-specific Marking Instructions for GCE Mathematics (OCR) Decision strand

- a. Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

- b. An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to mark correct solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be marked as correct if it is not a solution. Answers that are given in the question, especially, must be validly obtained; key steps in the working must be clearly shown and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such methods must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks if the method is in the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) discuss the method with your Team Leader.

- c. The following types of marks are available.

M

A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Marks are usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to state a formula or to quote a formula; the formula or idea must be applied to the specific problem in the question by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark is specified.

A

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B

Mark for a correct result or statement independent of Method marks.

- d. When a part of a question has two or more 'method' steps, the M marks are in principle independent units unless otherwise stated in the scheme; otherwise, and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate fails in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, if more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.
- e. The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect work. Otherwise, A and B marks are given for correct work only – differences in notation are of course permitted. A (accuracy) mark is given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a question, various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will be given for 'follow through'. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not in the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

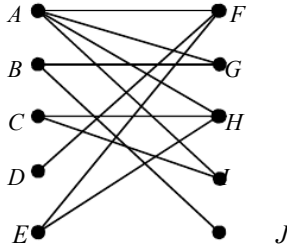
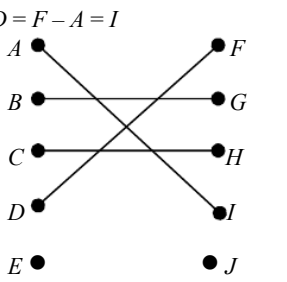
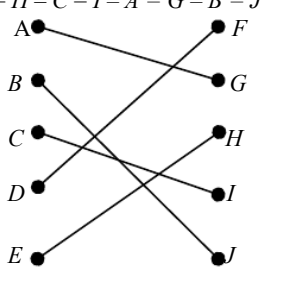
- f. Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise. Candidates are expected to give numerical answers to an appropriate degree of accuracy, with 3 significant figures often being the norm. The degree of accuracy to which an answer is given (eg 2 or 4 significant figures where 3 is expected) should not normally result in the loss of a mark. Answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding accuracy where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, consult your Team Leader.
- g. Rules for replaced work. NB Follow these maths-specific instructions rather than those in the assessor handbook.

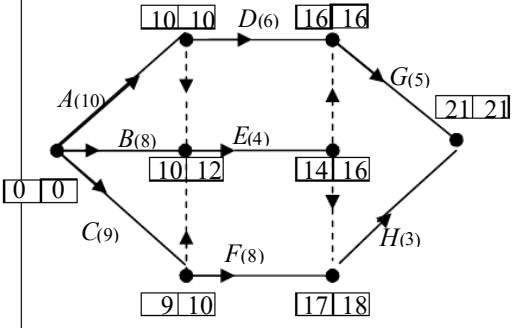
If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examine the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the (complete) attempt and ignore the others.

- h. For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain the same according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally withheld. This may differ for some units. This is achieved by withholding one A mark in the question.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

Question		Answer	Marks	
1	(i)		B1 [1]	Bipartite graph correct (ignore any extra thickening of lines, labels and an additional arc to X for alternating path)
1	(ii)	<p>$D = F - A = I$</p> 	B1 B1 [2]	A valid alternating path from D, written down in some form, from labels on graph. This matching drawn (cao)
1	(iii)	<p>$E = H - C = I - A = G - B = J$</p> 	B1 B1 [2]	This alternating path, written down in some form, from labels on graph. Allow reversed. This matching drawn (cao)
1	(iv)	<p>J can only pair with B and D must pair with F Hence G must pair with A, H must pair with E and C with I</p>	M1 A1 [2]	J must pair with B , D must pair with F Explaining why $A = G$, $C = I$ and $E = H$

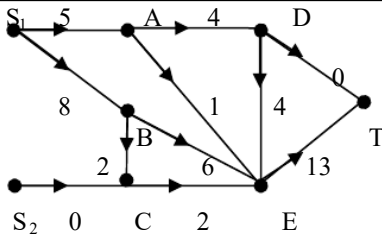
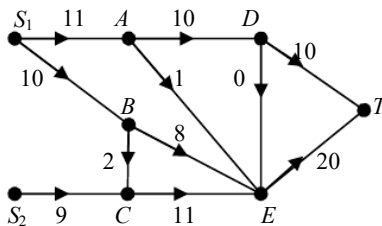
2	(i)	Question	Answer	Marks																												
2	(i)		<table border="1" data-bbox="379 212 853 526"> <thead> <tr> <th>Activity</th> <th>Duration</th> <th>Immediate predecessors</th> </tr> </thead> <tbody> <tr> <td>A</td> <td>10</td> <td>-</td> </tr> <tr> <td>B</td> <td>8</td> <td>-</td> </tr> <tr> <td>C</td> <td>9</td> <td>-</td> </tr> <tr> <td>D</td> <td>6</td> <td>A</td> </tr> <tr> <td>E</td> <td>4</td> <td>A, B, C</td> </tr> <tr> <td>F</td> <td>8</td> <td>C</td> </tr> <tr> <td>G</td> <td>5</td> <td>D, E</td> </tr> <tr> <td>H</td> <td>3</td> <td>E, F</td> </tr> </tbody> </table>	Activity	Duration	Immediate predecessors	A	10	-	B	8	-	C	9	-	D	6	A	E	4	A, B, C	F	8	C	G	5	D, E	H	3	E, F	<p>B1</p> <p>B1</p> <p>[2]</p>	<p>Immediate predecessors correct for A to F (blank implies 'none')</p> <p>Immediate predecessors correct for G and H</p>
Activity	Duration	Immediate predecessors																														
A	10	-																														
B	8	-																														
C	9	-																														
D	6	A																														
E	4	A, B, C																														
F	8	C																														
G	5	D, E																														
H	3	E, F																														
2	(ii)	 <p data-bbox="379 918 742 952">Min completion time = 21 minutes</p> <p data-bbox="379 974 654 1008">Critical activities: A, D, G</p>	<p>M1</p> <p>M1</p> <p>A1</p> <p>B1</p> <p>B1</p> <p>[5]</p>	<p>Forward pass with at most one independent error</p> <p>Backward pass with at most one independent error</p> <p>Both passes correct (cao)</p> <p>21 mins (cao) <u>with units</u></p> <p>A, D, G (cao)</p>																												

Question		Answer	Marks	
2	(iii)	<i>B</i> and <i>E</i>	M1 A1 [2]	Either correct and no critical activities Both correct and no incorrect activities (ca)
2	(iv)	It would increase by 2 mins <i>D</i> or <i>G</i>	B1 B1 [2]	Minimum completion time increases by 2, or time Either (or both) of the critical activities (cao)
2	(v)	1 minute delay	B1 [1]	1 or time is now 22 [(their) 21 + 1]

3	Question	Answer	Marks																																																	
3	(i)	<table border="1" data-bbox="379 219 730 383"> <thead> <tr> <th></th> <th><i>N</i></th> <th><i>P</i></th> <th><i>R</i></th> <th><i>T</i></th> </tr> </thead> <tbody> <tr> <th><i>J</i></th> <td>3</td> <td>2</td> <td>2</td> <td>2</td> </tr> <tr> <th><i>K</i></th> <td>2</td> <td>6</td> <td>5</td> <td>3</td> </tr> <tr> <th><i>L</i></th> <td>5</td> <td>9</td> <td>10</td> <td>6</td> </tr> <tr> <th><i>M</i></th> <td>2</td> <td>7</td> <td>6</td> <td>6</td> </tr> </tbody> </table> <p data-bbox="379 421 911 483">She needs to convert a maximising problem into a minimising problem</p>		<i>N</i>	<i>P</i>	<i>R</i>	<i>T</i>	<i>J</i>	3	2	2	2	<i>K</i>	2	6	5	3	<i>L</i>	5	9	10	6	<i>M</i>	2	7	6	6	<p data-bbox="975 271 1007 300">B1</p> <p data-bbox="975 421 1007 450">B1</p> <p data-bbox="975 483 1007 512">[2]</p>	<p data-bbox="1054 271 1586 300">This matrix, with or without row and column h</p> <p data-bbox="1054 421 1596 483">Hungarian algorithm finds allocation with minimum Maximising correct guesses is same as minimising</p>																							
	<i>N</i>	<i>P</i>	<i>R</i>	<i>T</i>																																																
<i>J</i>	3	2	2	2																																																
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<i>L</i>	5	9	10	6																																																
<i>M</i>	2	7	6	6																																																
3	(ii)	<p data-bbox="379 517 517 546">Reduce rows</p> <table border="1" data-bbox="421 539 703 667"> <tbody> <tr><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>4</td><td>3</td><td>1</td></tr> <tr><td>0</td><td>4</td><td>5</td><td>1</td></tr> <tr><td>0</td><td>5</td><td>4</td><td>4</td></tr> </tbody> </table> <p data-bbox="379 667 687 696">Columns are already reduced</p> <p data-bbox="379 819 592 848">Cross through zeros</p> <table border="1" data-bbox="421 842 703 969"> <tbody> <tr><td>1</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>4</td><td>3</td><td>1</td></tr> <tr><td>0</td><td>4</td><td>5</td><td>1</td></tr> <tr><td>0</td><td>5</td><td>4</td><td>4</td></tr> </tbody> </table> <p data-bbox="379 999 528 1028">Augment by 1</p> <table border="1" data-bbox="421 1021 703 1149"> <tbody> <tr><td>2</td><td>0</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>3</td><td>2</td><td>0</td></tr> <tr><td>0</td><td>3</td><td>4</td><td>0</td></tr> <tr><td>0</td><td>4</td><td>3</td><td>3</td></tr> </tbody> </table>	1	0	0	0	0	4	3	1	0	4	5	1	0	5	4	4	1	0	0	0	0	4	3	1	0	4	5	1	0	5	4	4	2	0	0	0	0	3	2	0	0	3	4	0	0	4	3	3	<p data-bbox="975 539 1007 568">M1</p> <p data-bbox="975 602 1007 631">A1</p> <p data-bbox="975 842 1007 871">M1</p> <p data-bbox="975 904 1007 934">A1</p>	<p data-bbox="1054 539 1596 568">Reducing rows or columns (for their matrix or for t</p> <p data-bbox="1054 602 1596 665">Reducing rows and columns correctly (no arithmetic Condone columns reduced first followed by rows</p> <p data-bbox="1054 725 1596 788">If original (speculations matrix) is used no augment further M or A marks.</p> <p data-bbox="1054 842 1596 934">Crossing through zeros using min no of lines and an uncovered value (method correct, including entries Correct augmented matrix (cao)</p>
1	0	0	0																																																	
0	4	3	1																																																	
0	4	5	1																																																	
0	5	4	4																																																	
1	0	0	0																																																	
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2	0	0	0																																																	
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0	3	4	0																																																	
0	4	3	3																																																	

3	Question	Answer	Marks																																	
3	(ii)	Augment by 2 <table border="1" data-bbox="427 215 708 338"> <tr><td>4</td><td>0</td><td>0</td><td>2</td></tr> <tr><td>0</td><td>1</td><td>0</td><td>0</td></tr> <tr><td>0</td><td>1</td><td>2</td><td>0</td></tr> <tr><td>0</td><td>2</td><td>1</td><td>3</td></tr> </table> Jill = police officer Kevin = radiographer Liz = teacher Mike = nurse	4	0	0	2	0	1	0	0	0	1	2	0	0	2	1	3	M1 A1 B1 B1 [8]	Crossing through zeros using min no of by min uncovered value (method correct, 1 twice) Correct augmented matrix (cao) Correctly describing how each table has been form rows', 'augment by 1', etc.) Correct allocation (cao) in words or symbols																
4	0	0	2																																	
0	1	0	0																																	
0	1	2	0																																	
0	2	1	3																																	
3	(iii)	Remove row for L and column for R <table border="1" data-bbox="384 607 857 730"> <tr><td></td><td>N</td><td>P</td><td>T</td></tr> <tr><td>J</td><td>7</td><td>8</td><td>8</td></tr> <tr><td>K</td><td>8</td><td>4</td><td>7</td></tr> <tr><td>M</td><td>8</td><td>3</td><td>4</td></tr> </table> $J = P$ $K = T$ $M = N$ This solution involves $8+7+8 = 23$ correct guesses. The maximum possible is 24, but that is not feasible since Kevin and Mike would both need to be the nurse (or Jill would have to be both the police officer and the teacher)		N	P	T	J	7	8	8	K	8	4	7	M	8	3	4	 B1 B1 [2]	Or on reduced cost matrix <table border="1" data-bbox="1158 607 1544 730"> <tr><td></td><td>N</td><td>P</td><td>T</td></tr> <tr><td>J</td><td>3</td><td>2</td><td>2</td></tr> <tr><td>K</td><td>2</td><td>6</td><td>3</td></tr> <tr><td>M</td><td>2</td><td>7</td><td>6</td></tr> </table> Same allocation as before except that now Kevin working) A valid explanation, using numbers of guesses or correct use of Hungarian from reduced start matrix reduced cost matrix from (ii) with third row and th		N	P	T	J	3	2	2	K	2	6	3	M	2	7	6
	N	P	T																																	
J	7	8	8																																	
K	8	4	7																																	
M	8	3	4																																	
	N	P	T																																	
J	3	2	2																																	
K	2	6	3																																	
M	2	7	6																																	

Question		Answer	Marks	
4	(i)	A supersource, S , and arc $S S_1$ with lower capacity 13, and upper capacity ≥ 22 .	B1	Or supersource, S , and arc $S S_1$ with 0 capacity ≥ 22
		A supersource, S , and arc $S S_2$ with lower capacity 0 and upper capacity ≥ 9	B1 [2]	
4	(ii)	Maximum = $8+10+10-2+15$ = 41 litres per second	M1 A1	Evidence of using -2 for arc BC 41, units not required
		Minimum = $3+1+8-3+2 = 11$ litres per second	B1 [3]	11, units not required
4	(iii)	Arcs crossed in forwards direction: $AD = 10, S_1B = 10, S_2C = 9, ED = 5, ET = 20$ Arcs crossed in backwards direction: $CE = -2, BE = -5$ (AE is crossed twice so any flow is cancelled out) $10+10+9-2-5+5+20 = 47$ (answer given)	M1 A1 [2]	Seeing evidence of -2 and -5 Not including AE (or cancelling it with itself, rather

4	Question	Answer	Marks	
4	(iv)	 <p>The diagram shows a network with nodes S_1, S_2, A, B, C, D, E, and T. Arcs and their flow values are: $S_1 \rightarrow A$ (5), $S_1 \rightarrow B$ (8), $S_2 \rightarrow C$ (0), $A \rightarrow D$ (4), $B \rightarrow C$ (2), $C \rightarrow E$ (2), $D \rightarrow E$ (4), $D \rightarrow T$ (0), $E \rightarrow T$ (13), $A \rightarrow E$ (1), and $B \rightarrow E$ (6).</p>	<p>M1 A1 [2]</p>	<p>May also show arcs from S, ignore the flow values (must be flows, not labelling procedure) Arcs S_1A, S_1B, S_2C, AE, CE and DT correct All correct, including direction on DE</p>
4	(v)	<p>$S_1ADT = 6$ $S_2CET = 7$ Total = 13</p>	<p>B1 [1]</p>	<p>13, or 6 and 7 or 6+7 (cao)</p>
4	(vi)	<p>Maximum flow = 30 For example, the flow in (iv) plus the extra 13 plus $S_1BEDT = 2$ and $S_2CEDT = 2$</p>  <p>The diagram shows a network with nodes S_1, S_2, A, B, C, D, E, and T. Arcs and their flow values are: $S_1 \rightarrow A$ (11), $S_1 \rightarrow B$ (10), $S_2 \rightarrow C$ (9), $A \rightarrow D$ (10), $B \rightarrow C$ (2), $C \rightarrow E$ (11), $D \rightarrow E$ (0), $D \rightarrow T$ (10), $E \rightarrow T$ (20), $A \rightarrow E$ (1), and $B \rightarrow E$ (8).</p> <p>Cut $\{S_1, S_2, A, B, C, D, E\}, \{T\}$ is saturated</p>	<p>B1 B1 [2]</p>	<p>Could 'start from scratch' or give a description of flow 30 and a valid flow shown on diagram (assume blank diagram required on DE if no flow in it) Or 30 and a convincing description of flow (do not need to say explicitly that this shows that 30 is max) This cut described in any way and some words like 'max flow = min cut' without further explanation</p>

Question		Answer	Marks																															
5	(i)	4 when he chooses \diamond	B1 [1]	4 and \diamond																														
5	(ii)	<p>\blacklozenge is dominated by \blacksquare</p> <p>Rose always wins more by choosing \blacksquare $(4 > 2, -3 > -5, 4 > -2 \text{ and } 5 > -1)$ Colin should never choose \triangle</p> <table style="margin-left: 40px;"> <tr> <td></td> <td>\circ</td> <td>\square</td> <td>\diamond</td> </tr> <tr> <td>\bullet</td> <td>-2</td> <td>3</td> <td>-4</td> </tr> <tr> <td>\blacksquare</td> <td>4</td> <td>-3</td> <td>4</td> </tr> <tr> <td>\blacktriangle</td> <td>-6</td> <td>5</td> <td>-5</td> </tr> </table>		\circ	\square	\diamond	\bullet	-2	3	-4	\blacksquare	4	-3	4	\blacktriangle	-6	5	-5	B1 M1 A1 [3]	<p>\blacksquare dominates or \blacksquare is <u>always</u> better or correct</p> <p>\triangle</p> <p>This reduced matrix (cao)</p>														
	\circ	\square	\diamond																															
\bullet	-2	3	-4																															
\blacksquare	4	-3	4																															
\blacktriangle	-6	5	-5																															
5	(iii)	<table style="margin-left: 40px;"> <tr> <td></td> <td>\circ</td> <td>\square</td> <td>\diamond</td> <td>row min</td> </tr> <tr> <td>\bullet</td> <td>-2</td> <td>3</td> <td>-4</td> <td>-4</td> </tr> <tr> <td>\blacksquare</td> <td>4</td> <td>-3</td> <td>4</td> <td>-3 ←</td> </tr> <tr> <td>\blacktriangle</td> <td>-6</td> <td>5</td> <td>-5</td> <td>-6</td> </tr> <tr> <td>col</td> <td>4</td> <td>5</td> <td>4</td> <td></td> </tr> <tr> <td>max</td> <td>↑</td> <td></td> <td>↑</td> <td></td> </tr> </table> <p>Play-safe for Rose is \blacksquare Play-safes for Colin are \circ and \diamond</p> <p>Not stable, $4 \neq -3$</p>		\circ	\square	\diamond	row min	\bullet	-2	3	-4	-4	\blacksquare	4	-3	4	-3 ←	\blacktriangle	-6	5	-5	-6	col	4	5	4		max	↑		↑		M1 M1 A1 B1 [4]	<p>Row min values shown</p> <p>Column maxima (or their negatives) shown \blacksquare, \circ and \diamond written down (ft their table), depend</p> <p>Not stable and a valid reason (eg if R plays \blacksquare then (ft their table, including stable/not stable)</p>
	\circ	\square	\diamond	row min																														
\bullet	-2	3	-4	-4																														
\blacksquare	4	-3	4	-3 ←																														
\blacktriangle	-6	5	-5	-6																														
col	4	5	4																															
max	↑		↑																															

Question		Answer	Marks										
5	(iv)	<p>On the reduced matrix, add 6 throughout to remove negative values</p> <table border="1" style="margin-left: auto; margin-right: auto;"> <tr> <td>4</td> <td>9</td> <td>2</td> </tr> <tr> <td>10</td> <td>3</td> <td>10</td> </tr> <tr> <td>0</td> <td>11</td> <td>1</td> </tr> </table> <p>If Colin chooses <input type="checkbox"/> then Rose can expect to win $9x + 3y + 11z$ points</p>	4	9	2	10	3	10	0	11	1	<p>M1</p> <p>A1</p> <p>[2]</p>	<p>Add 6 to values in table (either described or table shown, or at least one value added)</p> <p><input type="checkbox"/> column identified</p>
4	9	2											
10	3	10											
0	11	1											
5	(v)	<p>Using $x = \frac{7}{48}$, $y = \frac{27}{48}$, $z = \frac{14}{48}$</p> <p>$4x + 10y = \frac{298}{48}$ or $6\frac{5}{24}$ or 6.21</p> <p>$9x + 3y + 11z = \frac{298}{48}$ or $6\frac{5}{24}$ or 6.21</p> <p>$2x + 10y + z = \frac{298}{48}$ or $6\frac{5}{24}$ or 6.21</p> <p>$m = 6\frac{5}{24} \Rightarrow M = \frac{5}{24}$</p>	<p>M1</p> <p>A1</p> <p>[2]</p>	<p>$\frac{298}{48}$ or $6\frac{5}{24}$ or 6.21 (to 3 sf) (cao), even if seen with M from only one expression (may be implied from M)</p> <p>$\frac{5}{24}$ or 0.208 (to 3 sf) or 0.21 (to 2 sf) (cao)</p>									

Question		Answer	Marks																																																							
6	(i)	<p>(4; 0) would mean that at the start of Friday morning Simon has no houses in store.</p> <p>He needs four houses for Friday, but he can only make at most three, so he needs at least one in store.</p>	<p>M1</p> <p>A1</p> <p>[2]</p>	<p>Understanding that (4; 0) means no houses in store</p> <p>Explaining why he would need at least one house in store</p>																																																						
6	(ii)		<p>B1</p> <p>B1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>B1</p> <p>[6]</p>	<p>Arcs correct for Tuesday</p> <p>Arcs correct for Wednesday</p> <p>Arcs correct for Thursday</p> <p>Weights (costs) correct for Friday</p> <p>Weights correct for Tuesday to Thursday (ft arcs, p)</p> <p>Weights correct for Monday</p>																																																						
6	(iii)	<table border="1"> <thead> <tr> <th>Stage</th> <th>State</th> <th>Action</th> <th>Working</th> <th>Suboptimal minimum</th> </tr> </thead> <tbody> <tr> <td rowspan="2">4</td> <td>1</td> <td>0</td> <td>9</td> <td>9</td> </tr> <tr> <td>2</td> <td>0</td> <td>4</td> <td>4</td> </tr> <tr> <td rowspan="3">3</td> <td>0</td> <td>1</td> <td>9 + 9 = 18</td> <td>18</td> </tr> <tr> <td rowspan="2">1</td> <td>1</td> <td>4 + 9 = 13</td> <td rowspan="2">13</td> </tr> <tr> <td>2</td> <td>9 + 4 = 13</td> </tr> <tr> <td rowspan="3">2</td> <td>0</td> <td>0</td> <td>4 + 18 = 22</td> <td>22</td> </tr> <tr> <td rowspan="2">1</td> <td>0</td> <td>1 + 18 = 19</td> <td rowspan="2">17</td> </tr> <tr> <td>1</td> <td>4 + 13 = 17</td> </tr> <tr> <td rowspan="3">1</td> <td>0</td> <td>0</td> <td>9 + 22 = 31</td> <td>31</td> </tr> <tr> <td rowspan="2">1</td> <td>0</td> <td>4 + 22 = 26</td> <td rowspan="2">26</td> </tr> <tr> <td>1</td> <td>9 + 17 = 26</td> </tr> <tr> <td rowspan="2">0</td> <td rowspan="2">0</td> <td>0</td> <td>8 + 31 = 39</td> <td rowspan="2">39</td> </tr> <tr> <td>1</td> <td>27 + 26 = 53</td> </tr> </tbody> </table>	Stage	State	Action	Working	Suboptimal minimum	4	1	0	9	9	2	0	4	4	3	0	1	9 + 9 = 18	18	1	1	4 + 9 = 13	13	2	9 + 4 = 13	2	0	0	4 + 18 = 22	22	1	0	1 + 18 = 19	17	1	4 + 13 = 17	1	0	0	9 + 22 = 31	31	1	0	4 + 22 = 26	26	1	9 + 17 = 26	0	0	0	8 + 31 = 39	39	1	27 + 26 = 53	<p>B1</p> <p>M1</p> <p>A1</p> <p>B1</p> <p>M1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>[8]</p>	<p>Follow through their part (ii) if possible for M and A</p> <p>Columns for stage, state, action and at least one other work</p> <p>Stage and state values correct, starting from stage 4</p> <p>Action values correct (= state value for next stage)</p> <p>Suboptimal min values correct for stage 4</p> <p>Correct method for stage 3</p> <p>Correct method for stage 2</p> <p>Correct method for stage 1</p> <p>Completely correct values for suboptimal minima (all three method marks)</p>
Stage	State	Action	Working	Suboptimal minimum																																																						
4	1	0	9	9																																																						
	2	0	4	4																																																						
3	0	1	9 + 9 = 18	18																																																						
	1	1	4 + 9 = 13	13																																																						
		2	9 + 4 = 13																																																							
2	0	0	4 + 18 = 22	22																																																						
	1	0	1 + 18 = 19	17																																																						
		1	4 + 13 = 17																																																							
1	0	0	9 + 22 = 31	31																																																						
	1	0	4 + 22 = 26	26																																																						
		1	9 + 17 = 26																																																							
0	0	0	8 + 31 = 39	39																																																						
		1	27 + 26 = 53																																																							
6	(iv)	<p>Mon Tue Wed Thurs Friday</p> <p>2 3 2 3 3</p>	<p>B1</p> <p>[1]</p>	<p>Cao</p>																																																						

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