

GCE

Mathematics

Unit **4736**: Decision Mathematics 1

Advanced Subsidiary GCE

Mark Scheme for June 2014

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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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1. These are the annotations, (including abbreviations), including those used in scoris, which are used when marking

Annotation in scoris	Meaning
BP	Blank Page – this annotation must be used on all blank pages within an answer booklet (structured or unstructured) and on each page of an additional object where there is no candidate response.
✓ 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

2. Here are the subject specific instructions for this question paper

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 either 0 or 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 assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at 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 work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact 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. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated 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.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

- d When a part of a question has two or more 'method' steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation 'dep *' is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong 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, when two or 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 results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. 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 often be '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 shown within 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. Small variations in the degree of accuracy to which an answer is given (e.g. 2 or 4 significant figures where 3 is expected) should not normally be penalised, while answers which are grossly over- or under-specified should normally result in the loss of a mark. The situation regarding any particular cases where the accuracy of the answer may be a marking issue should be detailed in the mark scheme rationale. If in doubt, contact your Team Leader.

g Rules for replaced work

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

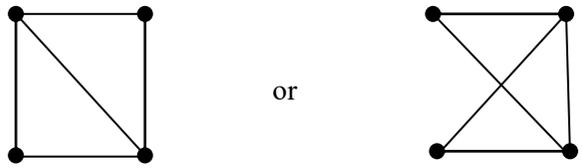
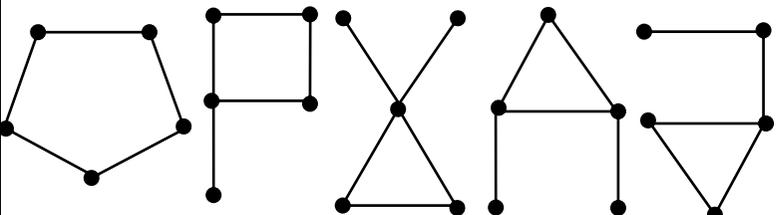
If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

h For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though 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	Guidance
1	(i)	120 120 120 100 120 150 200 250 150 200 250 3 deliveries	M1 A1 B1 [3]	May work horizontally or vertically (down or up) May use a diagrammatic form provided values are obvious First delivery does not include anything greater than 120 and second delivery is 150, 200, 250 in that order All correct, including putting the final 120 in the first delivery Stating 3 (cao)
1	(ii)	250 250 200 200 150 150 120 120 120 120 100 250 250 100 200 200 150 150 120 120 120 120 4 deliveries	B1 M1 A1 B1 [4]	List sorted into order (cao) (give BOD for increasing order) Values may be crossed out as part of subsequent working Using exactly 4 deliveries and second delivery is 200, 200, 150 in that order All correct, including putting the 100 in the first delivery Stating 4 (cao)
1	(iii)	eg 250 250 100 250 150 200 200 150 120 120 OR 120 120 250 100 200 150 120 120 150 120 120 200	M1 A1 [2]	All <u>11 boxes</u> in deliveries with <u>no more than 4</u> boxes in any one delivery - even if a large number of deliveries (even if this is a repeat of answer to part (ii), say) All correct, with 3 deliveries, boxes may be in any order and deliveries may be in any order

Question			Answer	Marks	Guidance
2	(i)	(a)	 <p>Graph is semi-Eulerian</p> <p>It has <u>exactly</u> 2 nodes of odd order</p>	<p>M1</p> <p>M1 ft</p> <p>A1</p> <p>[3]</p>	<p>Any graph that is topologically equivalent to this (the complete graph on 4 vertices with one arc removed)</p> <p>Follow through their graph for ‘Eulerian’, ‘semi-Eulerian’ or ‘neither’ (must have a graph)</p> <p>Allow ‘2 odd and 2 even’ but not just ‘2 odd nodes’, ‘nodes have order 2, 2, 3, 3’, etc.</p> <p>A mark is from <u>correct</u> graph only, dependent on both M marks</p>
2	(i)	(b)	<p>The sum of the vertex orders = $2 \times$ number of arcs = 10</p> <hr/> <p>(Simply connected, so each vertex order must be 1, 2 or 3)</p> <p>$3 + 3 + 3 + 1$</p> <p>(In a simple graph) a vertex of order 3 must connect to three other vertices. (There are only four vertices, so) each vertex of order 3 needs to connect to each of the others.</p> <p>This means that it is not possible to have three vertices of order 3</p> <hr/> <p>$3 + 3 + 2 + 2$</p> <p>There is only one way to make 3, 3, 2, 2 since the vertices of order 2 cannot be connected to one another <u>or</u> it is the complete graph (K_4) with one arc removed</p>	<p>B1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>[5]</p>	<p>10 (seen, but not from wrong working; or implied, e.g. from 2×5 or $3, 3, 2, 2$ or perhaps $4, 3, 2, 1$ or any set of four positive integers that sum to 10)</p> <p>Note: use of Euler’s relation $R+N=A+2$ gets no credit</p> <p>3, 3, 3, 1 seen (numerically or in words)</p> <p><u>Explaining</u> why three vertices of order 3 is not possible</p> <p>Allow ‘3, 3, 3, 1 would have to repeat an arc, so graph is not simple’ (not just a diagram)</p> <p>3, 3, 2, 2 seen (numerically or in words)</p> <p><u>Convincingly explaining</u> why there is only one way to make 3, 3, 2, 2 (not just a diagram)</p>
2	(ii)		<p>Graphs drawn that are topologically equivalent to the following</p> 	<p>M1</p> <p>A1</p> <p>A1</p> <p>[3]</p>	<p>Any one distinct and correct graph</p> <p>Another two distinct and correct graphs (to make three)</p> <p>Another two distinct and correct graphs (to make all five)</p> <p>Each graph must be simply connected and have 5 vertices and 5 arcs, ignore any extras or duplicates. Only credit each distinct type once.</p>

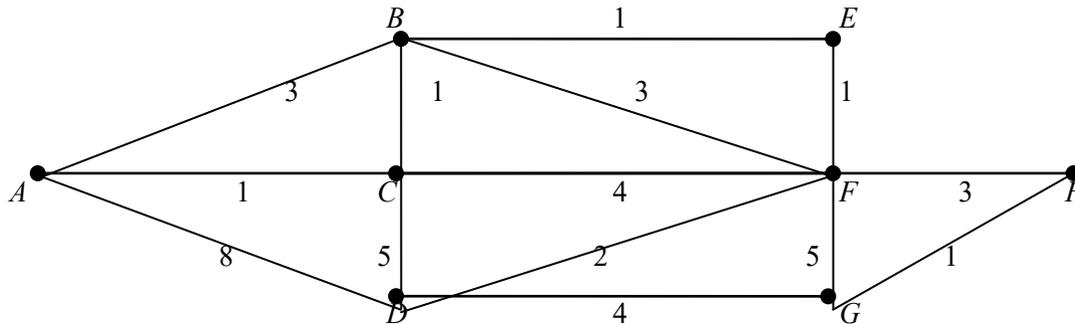
Question		Answer						Marks	Guidance
3	(i)	Line	<i>N</i>	<i>C</i>	<i>X</i>	<i>Y</i>	Print	M1 M1 dep M1 dep A1 [4]	<p>If candidate has used table differently try to follow their layout (e.g. written out all values, or squashed a pass into one line)</p> <p>$\sqrt{499}$ or 22.34 (allow 22.3 or better)</p> <p>Initial values for <i>C</i>, <i>X</i>, <i>Y</i> correct (condone <i>N</i> = 500 missing)</p> <p>$\sqrt{496}$ or $2\sqrt{124}$ or $4\sqrt{31}$ $\sqrt{496}$ or 22.27 (allow 22.3 or better)</p> <p>Second pass correct (values of <i>C</i>, <i>X</i>, <i>Y</i>) (<i>Y</i> = 22 may be implied)</p> <p>This mark is dependent on the previous M mark</p> <p>$\sqrt{491}$ or 22.16 (allow 22.2 or better)</p> <p>Third pass correct (values of <i>C</i>, <i>X</i>, <i>Y</i>) (<i>Y</i> = 22 may be implied)</p> <p>This mark is dependent on the previous M marks</p> <p>Output 4, 22 (or $\sqrt{484}$) in print column (without any wrong working or extra passes in <i>C</i>, <i>X</i>, <i>Y</i> columns).</p> <p>Ignore letters, if given. Accept 22, 4</p>
		10	500						
		20		1					
		40			$\sqrt{499}$				
		50				22			
		80		2					
		40			$\sqrt{496}$				
		50				22			
		80		3					
		40			$\sqrt{491}$				
		50				22			
		80		4					
		40			22				
		50				22			
100					4, 22				
3	(ii)	Line	<i>N</i>	<i>C</i>	<i>X</i>	<i>Y</i>	Print	M1 A1 [2]	<p>If candidate has used table differently try to follow their layout</p> <p>$\sqrt{6}$ or 2.45 (allow 2.4 or 2.5 or better)</p> <p>Initial values for <i>C</i>, <i>X</i>, <i>Y</i> correct (condone <i>N</i> = 7 missing)</p> <p>$\sqrt{3}$ or 1.73 (allow 1.7 or better)</p> <p>Second pass correct, and no further passes (no further working in <i>C</i>, <i>X</i>, <i>Y</i> columns, e.g. $C = 3 \Rightarrow A0$)</p>
		10	7						
		20		1					
		40			$\sqrt{6}$				
		50				2			
		80		2					
		40			$\sqrt{3}$				
		50				1			
110					FAIL				

Question		Answer	Marks	Guidance
3	(iii)	To <u>prevent</u> the algorithm from <u>looping indefinitely</u>	B1 [1]	Any appropriate reference to a <u>stopping</u> condition e.g. 'stop', 'end', 'terminate', '(otherwise) C would become infinite', '(otherwise) it continues (forever)'
3	(iv)	$\sqrt{(12000 \div 3000)} \times 0.7$ = 1.4 seconds	M1 A1 [2]	Valid calculation shown, may be implied from 1.4 as answer e.g. 0.7 ↓ × 2 (or ×√4, or equivalent) 1.4 (units may be implied) Correct answer only, without rounding errors

4	Question	Answer	Marks	Guidance														
	(i)	<p>Diagram showing a network graph with nodes A, B, C, D, E, F, G, H. Edges and weights: A-B (3), A-C (1), A-D (8), B-C (1), B-E (1), B-F (3), C-D (5), C-F (4), D-E (4), D-G (4), E-F (1), F-G (5), F-H (3), G-H (1).</p> <p>Labels and boxes for nodes:</p> <ul style="list-style-type: none"> A: [1 0] (top), [] (bottom) B: [3 2] (top), [3 2] (bottom) C: [2 1] (top), [1] (bottom) D: [6 6] (top), [8 6] (bottom) E: [4 3] (top), [3] (bottom) F: [5 4] (top), [5 4] (bottom) G: [8 8] (top), [9 8] (bottom) H: [7 7] (top), [7] (bottom) <p>Table below the graph:</p> <table border="1" data-bbox="405 1171 1146 1254"> <thead> <tr> <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>200</td> <td>100</td> <td>600</td> <td>300</td> <td>400</td> <td>800</td> <td>700</td> </tr> </tbody> </table>	B	C	D	E	F	G	H	200	100	600	300	400	800	700	<p>M1</p> <p>M1 dep</p> <p>A1</p> <p>B1 ft</p> <p>B1 ft</p> <p>[5]</p>	<p>CHECK SPARE GRAPH and X whichever is not used</p> <p>Note: boxes must be used as indicated in answer book</p> <p>Temporary labels correct (with no extras) at B, C and D Temporary labels are NOT implied from permanent labels May use metres (300, 200; 100; 800, 600)</p> <p>Temporary labels correct (with no extras) at E, F and G May use metres (300; 500, 400; 900, 800)</p> <p>All permanent labels correct (not implied) cao May use metres. This mark is dependent on both M marks</p> <p>Order of labelling correct for <u>their</u> permanent labels. Use their permanent labels (strictly), condone 0 as label at A and all others reduced by 1 accordingly</p> <p>SCROLL DOWN FOR TABLE and second graph</p> <p>Follow through from their Dijkstra if possible, otherwise require correct distance(s), values <u>must be in metres</u></p>
B	C	D	E	F	G	H												
200	100	600	300	400	800	700												

Question		Answer	Marks	Guidance
4	(ii)	Odd nodes: A and G Shortest route A to $G = 800$ metres Length of shortest route = $4200 + 800$ $= 5000$ metres	B1 M1 A1 ft [3]	Identifying A and G as only odd nodes (must be seen, not implied). Could have $A=3, B=4$, etc., provided $A=3, G=3$ are the only odd nodes. (Note: $AG = 8$ is not enough) $4200 +$ their 800 (or $42 +$ their 8) ($4200 +$ their distance AG) (may be implied from their answer) 5000 , condone 50 if arc weights used throughout this part (units may be implied) (correct or ft)
4	(iii)	$A C B E F H$	B1 [1]	Allow AC, CB, \dots, FH or similar, but must be correct route Must be written, not a diagram
4	(iv)	Zac will finish searching for clues at $G = 4200$ m Shortest route from G to H is $GH = 100$ m Total = 4300 m	M1 A1 [2]	A to $G = 4200$ (may be implied from working or from answer) 4300 , condone 43 if arc weights used throughout this part, no follow through in this part (units may be implied)

For reference:



Question			Answer	Marks	Guidance
5	(i)	(a)	<p><i>G H F E B C A D G</i></p> <p>Upper bound = 2000 metres (or 2 km) $1 + 3 + 1 + 1 + 1 + 1 + 8 + 4 = 20$</p>	<p>M1</p> <p>A1</p> <p>B1</p> <p>[3]</p>	<p>Starts <i>G H F E B C A</i></p> <p>All correct and finishing at <i>G</i> (not ... <i>A C D G</i>)</p> <p>Allow <i>GH, HF, ... , DG</i> or similar, but written (not a diagram)</p> <p>2000 (metres may be implied) or 2 km (with units)</p> <p>Condone 20 if arc weights seen</p> <p>Correct answer without wrong working, allow ‘recovery’ of ‘return to <i>G</i>’ if route correct apart from <i>G</i> missing at end</p>
5	(i)	(b)	<i>A D G H F E B C A</i>	<p>B1</p> <p>[1]</p>	<p>Using their answer to part (i) that uses all 8 vertices, or correct, start and end at <i>A</i>. Order may be reversed: <i>A C B E F H G D A</i></p> <p>Allow <i>AD, DG, ... , CA</i> or other ways of presenting route</p>
5	(ii)		<p><i>AC</i> 1 <i>CB</i> 1 <i>BE</i> 1 <i>EF</i> 1 <i>FD</i> 2 <i>FH</i> 3 <i>HG</i> 1</p> <p>Total weight = 10</p>	<p>B1</p> <p>B1</p> <p>B1</p> <p>[3]</p>	<p>CHECK SPARE GRAPH and X whichever is not used</p> <p>Correct tree</p> <p><u>Arcs</u> in correct order <i>AC, BC, BE, EF, DF, FH, GH</i></p> <p>10 as total weight, condone 1000 m or 1 km if units are given, no follow through from an incorrect tree</p>

Question		Answer	Marks	Guidance
5	(iii) (a)	Remove FH and GH then reconnect G using DG $10 - 3 - 1 + 4 = 10$	B1 [1]	10 as final answer, condone 1000 m or 1 km if units are given, correct or follow through from part (ii) Need not see working
5	(iii) (b)	Reconnect H using HF and HG $10 + 3 + 1 = 14$ Lower bound = 1400 metres (or 1.4 km)	B1 [1]	1400 (metres may be implied) or 1.4 km (with units), condone 14 if using arc weights in (iii)(a) Strict follow through from part (iii)(a)
5	(iv)	e.g. $A C B E F H G D C A$ Length = 1800 metres or $A C B E F H G D F C A = 1900$ or $A C B E F H G D F E B C A = 1800$ or $A B E F H G D C A = 1900$ or $A C B E F D G H F C A = 1900$ etc. or any of these reversed	M1 A1 [2]	A valid route (starts and ends at A , visits all other nodes at least once) and has length strictly between their 1400, from (iii)(b), and their 2000, from (i)(a) Length of their route (metres may be implied), accept length in km if units are given, but not (their) 18 (unless stated that units are 100 m)
5	(v)	$18x + 8y \leq 120$ (or a positive multiple of this inequality) [coefficient of x comes from their length in (iv) $\div 100$] [coefficient of y must be 8, this is the number of vertices]	M1 A1 [2]	$18x + 8y$, follow through from part (iv) ≤ 120
5	(vi)	$7x + 5y > 40$ (or a positive multiple of this inequality) [coefficient of x is length of their route from A to $H \div 100$] [coefficient of y is the number of vertices on their route from A to H , including A but excluding H]	M1 A1 [2]	$7x + 5y$, follow through from part (iv) as far as $H > 40$ (allow ≥ 40) $A C B E F H G D C A$ gives $7x + 5y$, reversed = $11x + 4y$ $A C B E F H G D F C A$ gives $7x + 5y$, reversed = $12x + 5y$ $A C B E F H G D F E B C A$ gives $7x + 5y$, reversed = $11x + 7y$ $A B E F H G D C A$ gives $8x + 4y$, reversed = $11x + 4y$ $A C B E F D G H F C A$ gives $11x + 7y$, reversed = $8x + 3y$ etc.

Question		Answer	Marks	Guidance
6	(i)	$a =$ amount of amber lotion made, in litres $b =$ amount of bronze lotion made, in litres $c =$ amount of copper lotion made, in litres	B1	Associating a, b, c with <u>litres</u> of <u>amber</u> , <u>bronze</u> and <u>copper</u> , respectively Need to see ‘litres’, ‘amber’, ‘bronze’ and ‘copper’ used appropriately in defining variables a, b and c Not 100 ml
		Amount of water required = $1 \times a + 0.8 \times b + 0.5 \times c$ litres Amount available = 40 litres Hence, $a + 0.8b + 0.5c \leq 40 \Rightarrow 10a + 8b + 5c \leq 400$ (given)	B1	Sight of $a + 0.8b + 0.5c$ and 40 Not just ‘ $1 \times 10, 0.8 \times 10, 0.5 \times 10, 40 \times 10$ ’ Note: $10a + 8b + 5c \leq 400$ on its own gets B0
6	(ii)	$0.2b + 0.5c \leq 7 \Rightarrow 2b + 5c \leq 70$	B1	$2b + 5c \leq 70$, or any positive multiple of this, including decimals
			[1]	
6	(iii)	$2a + 4b + c \leq 176$ $5a + b + 3c \leq 80$	B1	Allow any positive multiple of this, including decimals
			B1	Allow any positive multiple of this, including decimals Must have inequalities, without slack variables
			[2]	
6	(iv)	£8	B1	Correct answer only (<u>with units</u> : £8, 8 pounds, 800 pence, 800p) £8 for A (may also see £7 for B, £4 for C) but not just $\pounds(8a + 7b + 4c)$ or similar
			[1]	

Question		Answer	Marks	Guidance																																																						
6	(v)	<p>Pivot on the 5 in the last row of column a</p> <table border="1"> <thead> <tr> <th>P</th> <th>a</th> <th>b</th> <th>c</th> <th>s</th> <th>t</th> <th>u</th> <th>v</th> <th>RHS</th> </tr> </thead> <tbody> <tr> <td>1</td> <td>0</td> <td>-5.4</td> <td>0.8</td> <td>0</td> <td>0</td> <td>0</td> <td>1.6</td> <td>128</td> </tr> <tr> <td>0</td> <td>0</td> <td>6</td> <td>-1</td> <td>1</td> <td>0</td> <td>0</td> <td>-2</td> <td>240</td> </tr> <tr> <td>0</td> <td>0</td> <td>2</td> <td>5</td> <td>0</td> <td>1</td> <td>0</td> <td>0</td> <td>70</td> </tr> <tr> <td>0</td> <td>0</td> <td>3.6</td> <td>-0.2</td> <td>0</td> <td>0</td> <td>1</td> <td>-0.4</td> <td>144</td> </tr> <tr> <td>0</td> <td>1</td> <td>0.2</td> <td>0.6</td> <td>0</td> <td>0</td> <td>0</td> <td>0.2</td> <td>16</td> </tr> </tbody> </table> <p> row 1' = (row 1) + 8 × (row 5') or (row 1) + 1.6 × (row 5) row 2' = (row 2) - 10 × (row 5') or (row 2) - 2 × (row 5) row 3' = (row 3) or no change or left blank row 4' = (row 4) - 2 × (row 5') or (row 4) - 0.4 × (row 5) row 5' = (row 5) ÷ 5 </p>	P	a	b	c	s	t	u	v	RHS	1	0	-5.4	0.8	0	0	0	1.6	128	0	0	6	-1	1	0	0	-2	240	0	0	2	5	0	1	0	0	70	0	0	3.6	-0.2	0	0	1	-0.4	144	0	1	0.2	0.6	0	0	0	0.2	16	<p>B1</p> <p>B1 ft</p> <p>M1</p> <p>A1</p> <p>B1 ft</p> <p>[5]</p>	<p>Order of rows may be changed throughout</p> <p>May be implied from entry ringed or from '1' in augmented tableau in column a row 5', or from 'row 5' = (row 5) ÷ 5'</p> <p>Pivot row correct in tableau (follow through their valid pivot choice provided pivot is from a, b or c column)</p> <p>A tableau with the correct structure (all cells filled, five different basis columns, no negative values in RHS column)</p> <p>Entirely correct tableau (do not follow through an incorrect pivot choice for this mark)</p> <p><u>All five</u> row operations correct (follow through their valid pivot choice provided pivot is from a, b or c column)</p> <p>Allow use of r1, pr, etc. but must be of form 'old row' ± appropriate multiple of (old or new) pivot row</p> <p>Do not accept row 1' = +8 row 5', row 1' = +8 × pivot, row 1' = +8, row 1' = row 1 + 8, or similar</p>
P	a	b	c	s	t	u	v	RHS																																																		
1	0	-5.4	0.8	0	0	0	1.6	128																																																		
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0	1	0.2	0.6	0	0	0	0.2	16																																																		
6	(vi)	No negative values in objective row	<p>B1</p> <p>[1]</p>	Top row all ≥ 0 (not 'top row positive')																																																						
6	(vii)	<p>$a = 9, b = 35, c = 0$</p> <p>Sandie should make 9 litres of amber lotion and 35 litres of bronze lotion</p> <p>Maximum profit = £317</p> <p>May be less because she may not sell it all</p>	<p>M1</p> <p>A1</p> <p>B1</p> <p>B1</p> <p>[4]</p>	<p>$a = 9, b = 35$ seen or implied</p> <p>Interpretation in context (need not refer to copper lotion)</p> <p>Need to see words 'litres', 'amber', 'bronze'</p> <p>Correct answer only (with units)</p> <p>May not sell it all (or equivalent)</p>																																																						
6	(viii)	<p>$s = 30$ so $10a + 8b + 5c = 370$, so at least 37 litres of water</p> <p><u>Or</u> $1 \times 9 + 0.8 \times 35 = 37$</p>	<p>B1</p> <p>[1]</p>	<p>Note: 370 as final answer \Rightarrow B0, unless stated as 'decilitres'</p> <p>37 ('litres' and context may be implied)</p>																																																						

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

OCR Customer Contact Centre

Education and Learning

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

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