

Q	Solution	Marks	Total	Comments																																								
5 (a)	$4x + 3y \leq 33$	M1	2																																									
	$-x + y \leq 4$	A1																																										
	$2x + 5y \leq 27$																																											
(b)	$\begin{array}{ccccccc} 4^* & 3 & 1 & 0 & 0 & 0 & 33 & (R_1) \\ -1 & 1 & 0 & 1 & 0 & 0 & 4 & (R_2) \\ 2 & 5 & 0 & 0 & 1 & 0 & 27 & (R_3) \\ -2 & -2 & 0 & 0 & 0 & 1 & 0 & \end{array}$			Alternative <table border="1"> <thead> <tr> <th>P</th> <th>n</th> <th>y</th> <th>r</th> <th>s</th> <th>t</th> <th>u</th> <th></th> </tr> </thead> <tbody> <tr> <td>1</td> <td>-2</td> <td>-2</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td></td> </tr> <tr> <td>0</td> <td>4</td> <td>3</td> <td>1</td> <td>0</td> <td>0</td> <td>33</td> <td>M1</td> </tr> <tr> <td>0</td> <td>-1</td> <td>1</td> <td>0</td> <td>1</td> <td>0</td> <td>4</td> <td></td> </tr> <tr> <td>0</td> <td>2</td> <td>5</td> <td>0</td> <td>0</td> <td>1</td> <td>27</td> <td></td> </tr> </tbody> </table>	P	n	y	r	s	t	u		1	-2	-2	0	0	0	0		0	4	3	1	0	0	33	M1	0	-1	1	0	1	0	4		0	2	5	0	0	1	27	
	P	n	y	r	s	t	u																																					
	1	-2	-2	0	0	0	0																																					
	0	4	3	1	0	0	33	M1																																				
	0	-1	1	0	1	0	4																																					
	0	2	5	0	0	1	27																																					
	Pivot about x, 4																																											
	$\begin{array}{ccccccc} 4 & 3 & 1 & 0 & 0 & 0 & 33 & R_1 \\ 0 & 7 & 1 & 4 & 0 & 0 & 49 & 4R_2+R_1 \\ 0 & 7^* & -1 & 0 & 2 & 0 & 21 & 2R_3-R_1 \\ 0 & -1 & 1 & 0 & 0 & 2 & 33 & 2R_4+R_1 \end{array}$	M1 m1 A1		<table border="1"> <tbody> <tr> <td>1</td> <td>0</td> <td>$-\frac{1}{2}$</td> <td>$\frac{1}{2}$</td> <td>0</td> <td>0</td> <td>$\frac{33}{2}$</td> <td>M1</td> </tr> <tr> <td>0</td> <td>1</td> <td>$\frac{3}{4}$</td> <td>$\frac{1}{4}$</td> <td>0</td> <td>0</td> <td>$\frac{33}{4}$</td> <td>A1</td> </tr> <tr> <td>0</td> <td>0</td> <td>$\frac{7}{4}$</td> <td>$\frac{1}{4}$</td> <td>1</td> <td>0</td> <td>$\frac{49}{4}$</td> <td></td> </tr> <tr> <td>0</td> <td>0</td> <td>$\frac{7}{2}$</td> <td>$\frac{1}{2}$</td> <td>0</td> <td>1</td> <td>$\frac{21}{2}$</td> <td>M1</td> </tr> </tbody> </table>	1	0	$-\frac{1}{2}$	$\frac{1}{2}$	0	0	$\frac{33}{2}$	M1	0	1	$\frac{3}{4}$	$\frac{1}{4}$	0	0	$\frac{33}{4}$	A1	0	0	$\frac{7}{4}$	$\frac{1}{4}$	1	0	$\frac{49}{4}$		0	0	$\frac{7}{2}$	$\frac{1}{2}$	0	1	$\frac{21}{2}$	M1								
	1	0	$-\frac{1}{2}$	$\frac{1}{2}$	0	0	$\frac{33}{2}$	M1																																				
	0	1	$\frac{3}{4}$	$\frac{1}{4}$	0	0	$\frac{33}{4}$	A1																																				
0	0	$\frac{7}{4}$	$\frac{1}{4}$	1	0	$\frac{49}{4}$																																						
0	0	$\frac{7}{2}$	$\frac{1}{2}$	0	1	$\frac{21}{2}$	M1																																					
Pivot about x, 7		M1																																										
$\begin{array}{ccccccc} 28 & 0 & 10 & 0 & -6 & 0 & 168 & 7R_1-3R_3 \\ 0 & 0 & 2 & 4 & -2 & 0 & 28 & R_2-R_3 \\ 0 & 7 & -1 & 0 & 2 & 0 & 21 & R_3 \\ 0 & 0 & 6 & 0 & 2 & 14 & 252 & 7R_4+R_3 \end{array}$	m1 A1		<table border="1"> <tbody> <tr> <td>1</td> <td>0</td> <td>0</td> <td>$\frac{3}{7}$</td> <td>0</td> <td>$\frac{1}{7}$</td> <td>18</td> <td>m1</td> </tr> <tr> <td>0</td> <td>1</td> <td>0</td> <td>$\frac{5}{14}$</td> <td>0</td> <td>$-\frac{3}{14}$</td> <td>6</td> <td></td> </tr> <tr> <td>0</td> <td>0</td> <td>0</td> <td>$\frac{1}{2}$</td> <td>1</td> <td>$-\frac{1}{2}$</td> <td>7</td> <td>A1</td> </tr> <tr> <td>0</td> <td>0</td> <td>1</td> <td>$-\frac{1}{7}$</td> <td>0</td> <td>$\frac{2}{7}$</td> <td>3</td> <td>B1</td> </tr> </tbody> </table>	1	0	0	$\frac{3}{7}$	0	$\frac{1}{7}$	18	m1	0	1	0	$\frac{5}{14}$	0	$-\frac{3}{14}$	6		0	0	0	$\frac{1}{2}$	1	$-\frac{1}{2}$	7	A1	0	0	1	$-\frac{1}{7}$	0	$\frac{2}{7}$	3	B1									
1	0	0	$\frac{3}{7}$	0	$\frac{1}{7}$	18	m1																																					
0	1	0	$\frac{5}{14}$	0	$-\frac{3}{14}$	6																																						
0	0	0	$\frac{1}{2}$	1	$-\frac{1}{2}$	7	A1																																					
0	0	1	$-\frac{1}{7}$	0	$\frac{2}{7}$	3	B1																																					
All positive, therefore optimal		B1	7																																									
(c)	$14P = 252$																																											
	$P = 18$	B1																																										
	$y = 3, x = 6$	B1	2	for both																																								
Total			11																																									

Q	Solution	Marks	Total	Comments	
4 (a)	$\begin{array}{cccccc c} x & y & z & r & s & P1 & \\ \hline 8 & 5 & 2 & 1 & 0 & 0 & 3 \\ 4 & 6^* & 9 & 0 & 1 & 0 & 2 \\ -4 & -5 & -3 & 0 & 0 & 1 & 0 \end{array}$	B1 B1	2		
	(b) Pivot y, 6				
	$\begin{array}{cccccc c} R_2 & 4 & 6 & 9 & 0 & 1 & 0 & 2 \\ 6R_1 - 5R_2 & 28^* & 0 & -33 & 6 & -5 & 0 & 8 \\ 6R_3 + 5R_2 & -4 & 0 & 27 & 0 & 5 & 6 & 10 \end{array}$	M1 M1 A1			Choosing pivot Attempt zeros CAO
	Pivot x, 28				
	$\begin{array}{cccccc c} 7R_1 - R_2 & 0 & 42 & 96 & -6 & 12 & 0 & 6 \\ R_2 & 28 & 0 & -33 & 6 & -5 & 0 & 8 \\ 7R_3 + R_2 & 0 & 0 & 156 & 6 & 30 & 42 & 78 \end{array}$	M1 M1 A1			As above CAO
	All +ve \therefore optimal	M1			
	$P = \frac{78}{42} = \frac{13}{7}$	A1F			If all +ve
	$z = 0$				
	$x = \frac{8}{28} = \frac{2}{7}$				
	$y = \frac{6}{42} = \frac{1}{7}$	A1F			As fractions
Total			9		
Total			11		

Q	Solution	Marks	Total	Comments			
8(a)	$\begin{array}{cccccc} P & x & y & s & t & u \\ \hline 1 & 0 & 0 & 0 & 1/4 & -1/4 & 18 \\ 0 & 0 & 0 & 1 & 1/2 & 1/2 & 14 \\ 0 & 0 & 1 & 0 & 1/4 & -1/4 & 3 \\ 0 & 1 & 0 & 0 & 3/4 & 1/4 & 12 \end{array}$	B1 B1 M1 A1 A1	5	Choice of pivot Pivot \rightarrow 1 Row manipulations			
	(ii) Still a negative in top row	B1			1		
	(b)(i) P's maximum is 25 Reached at (5,10)	B1 B1			2		
	(ii) $T_0 : O$ $T_1 : D$ $T_2 : C$ $T_3 : B$	B1 B1 B1			3	Any two Another Another	
	(iii) Start by pivoting in y's column	M1 A1			2		
	Total					13	
	Paper total					80	