

Question Number	Scheme	Marks										
1.	<p style="text-align: center;">         6    1    18    12    9    0    5    13    14          18    12    13    14    9    6    1    0    5          18    14    13    12    9    6    1    5    0          18    14    13    12    9    6    5    1    0          18    14    13    12    9    6    5    1    0          18    14    13    12    9    6    5    1    0       </p> <p>Datchet (18), Wraysbury (14), Staines (13), Feltham (12), Halliford (9), Ashford (6), Poyle (5), Colnbrook (1), Laleham (0).</p>	M1  A1  A1  A1  A1  A1        (5) (5 marks)										
2. (a)	<p>No negative elements in the profit row.</p>	B1        (1)										
(b)	$P = 11, x = 1, y = \frac{1}{3}, z = 0; r = \frac{2}{3}s = 0, t = 0$	M1 A1; A1 (3)										
(c)	$P + z + s + t = 11$ $\Rightarrow P = 11 - z - s - t$ so increasing $z, s$ or $t$ would decrease $P$ .	B1  B1        (2)										
3. (a)	<table style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 50%;">1 – C</td> <td style="width: 50%;">1 – C</td> </tr> <tr> <td>2 – B</td> <td>2 – A</td> </tr> <tr> <td>3 – B</td> <td>and 3 – D</td> </tr> <tr> <td>4 – E</td> <td>4 – B</td> </tr> <tr> <td>5 – D</td> <td>5 – A</td> </tr> </table> (b) $2 - B = 4 - C = 1 - E$ $2 - D = 5 - E$	1 – C	1 – C	2 – B	2 – A	3 – B	and 3 – D	4 – E	4 – B	5 – D	5 – A	B1  B1        (2)    M1 A1  M1 A1     (4) (6 marks)
1 – C	1 – C											
2 – B	2 – A											
3 – B	and 3 – D											
4 – E	4 – B											
5 – D	5 – A											

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4. (a)		M1 A1 A1 (3)
(b)(i)	<p>Shortest route <math>ABFEHI</math>, length 22 km</p> <p>Odd vertices <math>A</math> and <math>I</math> only, shortest route between them needs to be repeated, hence repeat</p> <p><math>AB, BF, FE, EH, HI</math></p>	B1 B1 (2) M1 A1
(ii)	<p>e.g. <u><math>AB</math></u><u><math>FB</math></u><u><math>EFG</math></u><u><math>GIF</math></u><u><math>EH</math></u><u><math>IHE</math></u><u><math>CDA</math></u><u><math>CB</math></u></p> <p><math>91 + 22 = 113</math> km</p>	A1 (3) M1 A1 (2) <b>(Marks 10)</b>

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5. (a)	<table border="1" style="width: 100%; border-collapse: collapse;"> <thead> <tr> <th><i>a</i></th><th><i>b</i></th><th><i>c</i></th><th><i>d</i></th><th><i>e</i></th><th><i>f</i></th><th><i>f</i>=0?</th></tr> </thead> <tbody> <tr> <td>645</td><td>255</td><td>2.53</td><td>2</td><td>510</td><td>135</td><td>No</td></tr> <tr> <td>255</td><td>135</td><td>1.89</td><td>1</td><td>135</td><td>120</td><td>No</td></tr> <tr> <td>135</td><td>120</td><td>1.13</td><td>1</td><td>120</td><td>15</td><td>No</td></tr> <tr> <td>120</td><td>15</td><td>8</td><td>8</td><td>120</td><td>0</td><td>Yes</td></tr> <tr> <td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr> <td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>f</i> =0?	645	255	2.53	2	510	135	No	255	135	1.89	1	135	120	No	135	120	1.13	1	120	15	No	120	15	8	8	120	0	Yes															M1 A1 M1 A1 A1 A1
<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>f</i> =0?																																													
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135	120	1.13	1	120	15	No																																													
120	15	8	8	120	0	Yes																																													
	The answer is 15	A1 (7)																																																	
(b)	The first row would be 255 645 0.40 0 0 255 No	M1 A1																																																	
	But the second row would then be the same as the first row above, and the solution thereafter would be the same.	A1 (3)																																																	
(c)	Finds the H.C.F of <i>a</i> and <i>b</i> .	B1 (1) <b>(11 marks)</b>																																																	

Question Number	Scheme	Marks
6. (a)	Critical activities $B, F, J, K, N$ (not $I$ ); length 25 hours	B1; B1 (2)
(b)	$A = 5 - 0 - 3 = 2$ $E = 9 - 3 - 4 = 2$ $L = 22 - 11 - 4 = 7$ $C = 9 - 0 - 6 = 3$ $G = 9 - 4 - 3 = 2$ $M = 22 - 16 - 2 = 4$ $D = 11 - 3 - 3 = 5$ $H = 16 - 7 - 7 = 2$ $P = 25 - 18 - 3 = 4$ $I = 16 - 9 - 5 = 2$	M1 A1 ft A1 (3)
(c)		M1 A1 A1 ft A1 ft
(d)	 3 workers needed Precedences: 	M1 A1 A1 (3) (12 marks)

ft = follow through mark

Question Number	Scheme	Marks
7. (a)		M1 A1 (2)
(b) (i)	$SF_1 ABR = 6$	B1
(ii)	$SF_3 CR = 8$	B1 (2)
(c)(1)		
(c)(2)		M1 A1
	e.g. $SF_1 BR = 6$ , $SF_2 BR = 3$ , $SF_2 CR = 3$ , $SF_3 R = 4$	A1 A1
	Total flow = 30	A1 (5)
(ii)	Max flow – min cut theorem	M1
	Cut $BR, F_2C, F_3C, F_3R$	A1 (2)
	<b>(11 marks)</b>	

Question Number	Scheme	Marks
8. (a)	$x + y \geq 380$ $y \geq 125$ $2x + 4y \leq 1200$	B1 B1 B1 (3)
(b)	$c = 3x + 2y$	B1 (1)
(c)	<p>The graph shows the feasible region for a linear programming problem. The x-axis ranges from 0 to 600 with increments of 100. The y-axis ranges from 0 to 500 with increments of 100. Three constraint lines are plotted: <math>x + y = 380</math> (intercepting x at 380 and y at 380), <math>y = 125</math> (a horizontal line), and <math>2x + 4y = 1200</math> (intercepting x at 600 and y at 300). The feasible region is the shaded area in the first quadrant bounded by these lines, with vertices at (0,0), (380, 0), (300, 125), and (0, 125).</p>	B1 B1 B1 B1 (4)
	Use of profit line or points testing	M1
	Minimum intersection of $x + y = 380$ and $2x + 4y = 1200$	
	$x = 160, y = 120, \text{ cost} = £920$	A1 A1 (3)
(d)	Maximum at intersection of $y = 125$ and $2x + 4y = 1200$	M1
	$x = 350, y = 125, \text{ cost} = £1300$	A1 A1 (3)
		(14 marks)