

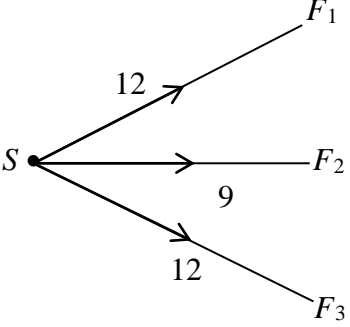
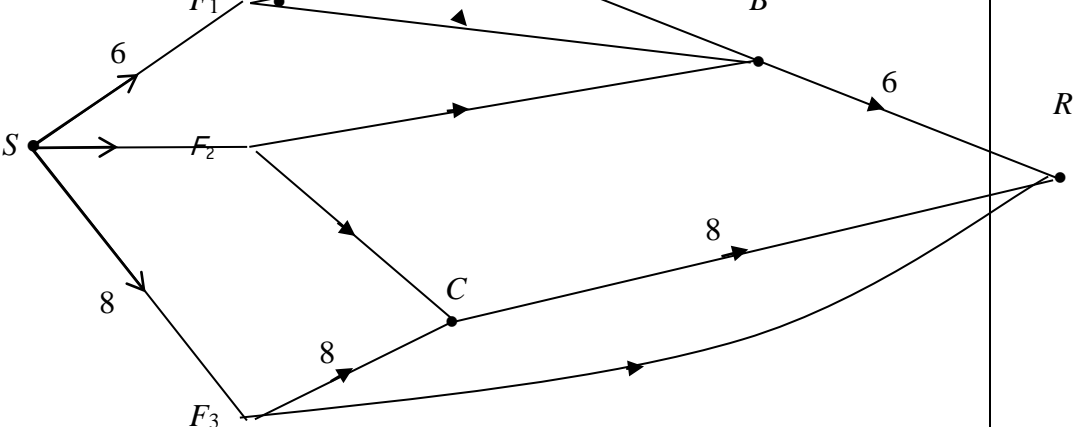
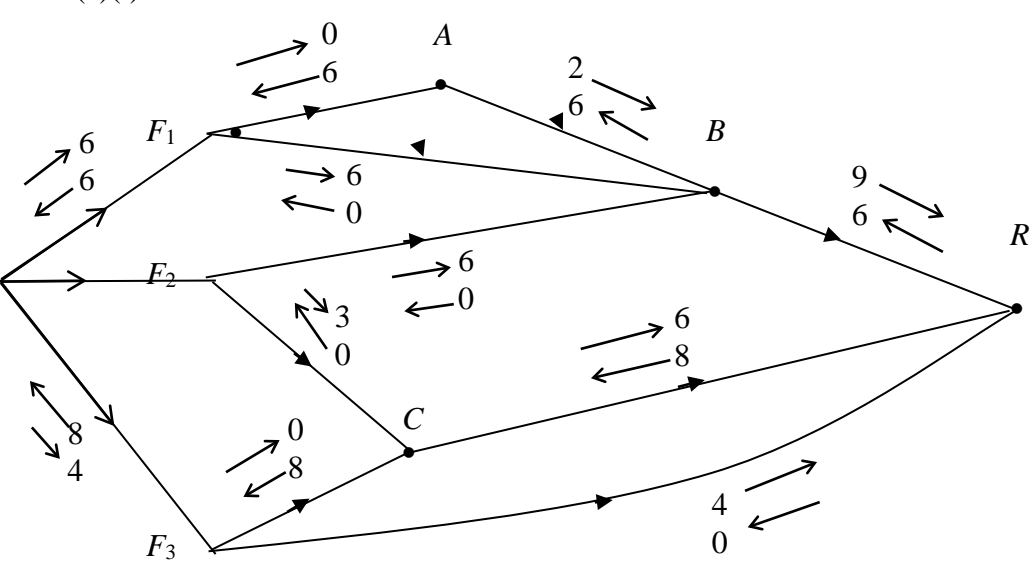
Question Number	Scheme	Marks
1.	<p style="text-align: center;"> 6 1 18 12 (9) 0 5 13 14 18 12 (13) 14 (9) 6 1 (0) 5 18 (14) (13) (12) (9) 6 (1) 5 (0) (18) (14) (13) (12) (9) 6 (5) (1) (0) (18) (14) (13) (12) (9) (6) (5) (1) (0) (18) (14) (13) (12) (9) 6 5 1 0 </p> <p>Datchet (18), Wraysbury (14), Staines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

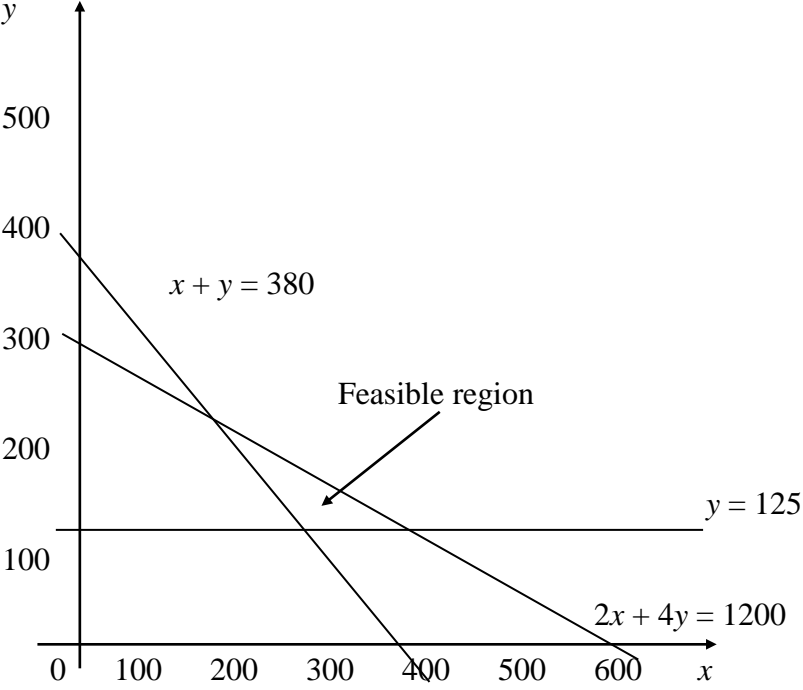
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<p>4. (a)</p> <div style="display: flex; align-items: center; justify-content: space-between;"> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">1</td><td style="border: 1px solid black;">0</td></tr> <tr><td colspan="2" style="border: 1px solid black;">0</td></tr> </table> </div> <div style="text-align: center;"> </div> <div style="border: 1px solid black; padding: 2px; margin-left: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">9</td><td style="border: 1px solid black;">22</td></tr> <tr><td colspan="2" style="border: 1px solid black;">24 23 22</td></tr> </table> </div> </div>	1	0	0		9	22	24 23 22		<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">3</td><td style="border: 1px solid black;">12</td></tr> <tr><td colspan="2" style="border: 1px solid black;">12 (15)</td></tr> </table> </div> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">5</td><td style="border: 1px solid black;">15</td></tr> <tr><td colspan="2" style="border: 1px solid black;">15</td></tr> </table> </div> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">7</td><td style="border: 1px solid black;">18</td></tr> <tr><td colspan="2" style="border: 1px solid black;">18</td></tr> </table> </div> </div> <div style="display: flex; justify-content: space-between; align-items: center; margin-top: 10px;"> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">2</td><td style="border: 1px solid black;">10</td></tr> <tr><td colspan="2" style="border: 1px solid black;">10</td></tr> </table> </div> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">6</td><td style="border: 1px solid black;">17</td></tr> <tr><td colspan="2" style="border: 1px solid black;">22 18 17</td></tr> </table> </div> <div style="border: 1px solid black; padding: 2px; margin-right: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">8</td><td style="border: 1px solid black;">20</td></tr> <tr><td colspan="2" style="border: 1px solid black;">20</td></tr> </table> </div> </div> <div style="border: 1px solid black; padding: 2px; margin-top: 10px;"> <table style="border-collapse: collapse; width: 40px; text-align: center;"> <tr><td style="border: 1px solid black;">1</td><td style="border: 1px solid black;">14</td></tr> <tr><td colspan="2" style="border: 1px solid black;">15 14</td></tr> </table> </div>	3	12	12 (15)		5	15	15		7	18	18		2	10	10		6	17	22 18 17		8	20	20		1	14	15 14		<div style="display: flex; justify-content: space-between; align-items: center;"> <div style="margin-right: 10px;">M1 A1 A1</div> <div style="text-align: right;">(3)</div> </div> <p style="margin-top: 10px;">Shortest route <i>ABFEHI</i>, length 22 km</p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="margin-right: 10px;">B1 B1</div> <div style="text-align: right;">(2)</div> </div> <p style="margin-top: 10px;">(b)(i) Odd vertices <i>A</i> and <i>I</i> only, shortest route between them needs to be repeated, hence repeat <i>AB, BF, FE, EH, HI</i></p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="margin-right: 10px;">M1</div> <div style="text-align: right;">A1</div> </div> <p style="margin-top: 10px;">(ii) e.g. $\overline{ABFBFEFGIFEHIHECDACBA}$</p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="margin-right: 10px;">A1</div> <div style="text-align: right;">(3)</div> </div> <p style="margin-top: 10px;">(ii) $91 + 22 = 113$ km</p> <div style="display: flex; justify-content: space-between; align-items: center;"> <div style="margin-right: 10px;">M1 A1</div> <div style="text-align: right;">(2)</div> </div> <p style="text-align: right; margin-top: 10px;">(Marks 10)</p>
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<p>5. (a)</p>	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>e</i>	<i>f</i>	<i>f = 0?</i>		
	645	255	2.53	2	510	135	No		M1 A1
	255	135	1.89	1	135	120	No		M1 A1
	135	120	1.13	1	120	15	No		A1
	120	15	8	8	120	0	Yes		A1

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

ft = follow through mark

Question Number	Scheme	Marks
7. (a)		M1 A1 (2)
(b) (i)	$SF_1ABR = 6$	B1
(b) (ii)	$SF_3CR = 8$	B1 (2)
(c)(i)		
(c)(i)		M1 A1
(i)	<p>e.g. $SF_1BR = 6$, $SF_2BR = 3$, $SF_2CR = 3$, $SF_3R = 4$</p> <p>Total flow = 30</p>	A1 A1 (5)
(ii)	<p>Max flow – min cut theorem</p> <p>Cut BR, F_2C, F_3C, F_3R</p>	M1 A1 (2)

Question Number	Scheme	Marks
8. (a)	$x + y \geq 380$	B1
	$y \geq 125$	B1
	$2x + 4y \leq 1200$	B1 (3)
(b)	$c = 3x + 2y$	B1 (1)
(c)	 <p data-bbox="279 1232 718 1276">Use of profit line or points testing</p> <p data-bbox="279 1288 1005 1332">Minimum intersection of $x + y = 380$ and $2x + 4y = 1200$</p> <p data-bbox="279 1344 670 1388">$x = 160, y = 120, \text{ cost} = \text{£}920$</p> <p data-bbox="279 1400 973 1444">(d) Maximum at intersection of $y = 125$ and $2x + 4y = 1200$</p> <p data-bbox="279 1456 686 1500">$x = 350, y = 125, \text{ cost} = \text{£}1300$</p>	<p data-bbox="1284 739 1324 784">B1</p> <p data-bbox="1284 795 1324 840">B1</p> <p data-bbox="1284 851 1324 896">B1</p> <p data-bbox="1284 907 1324 952">B1 (4)</p> <p data-bbox="1284 1232 1324 1276">M1</p> <p data-bbox="1284 1344 1372 1388">A1 A1 (3)</p> <p data-bbox="1284 1400 1324 1444">M1</p> <p data-bbox="1284 1456 1372 1500">A1 A1 (3)</p> <p data-bbox="1324 1512 1476 1556">(14 marks)</p>