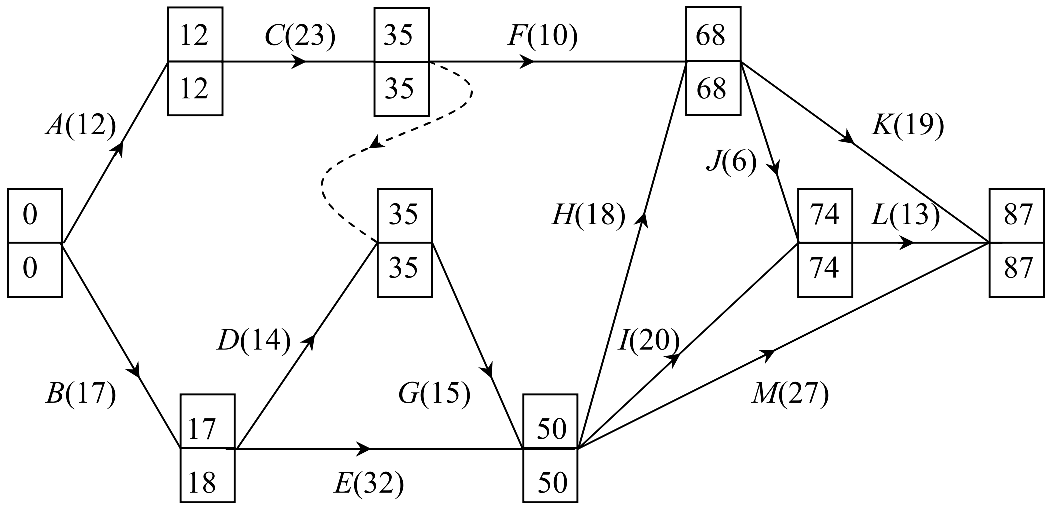
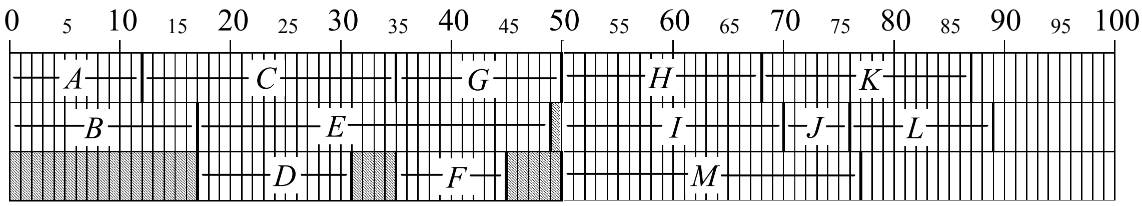
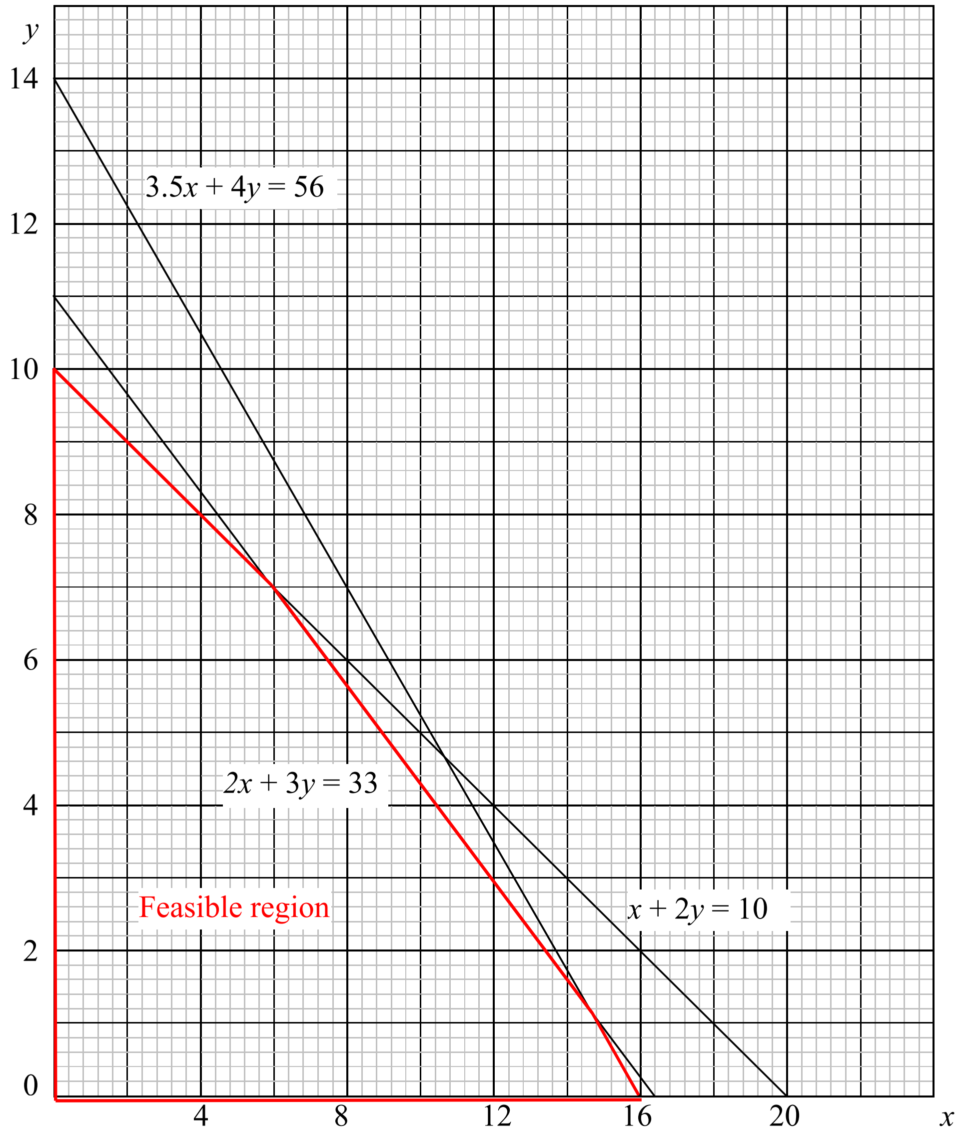
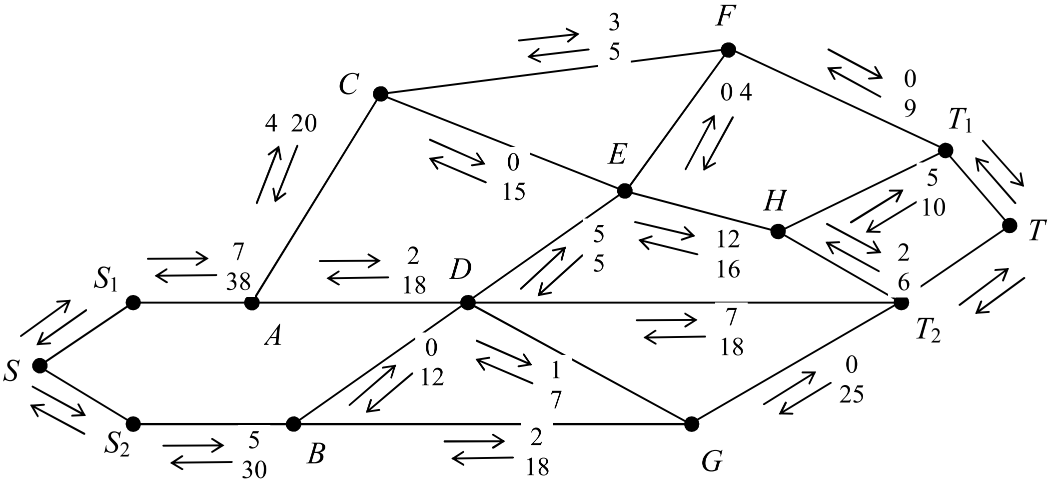
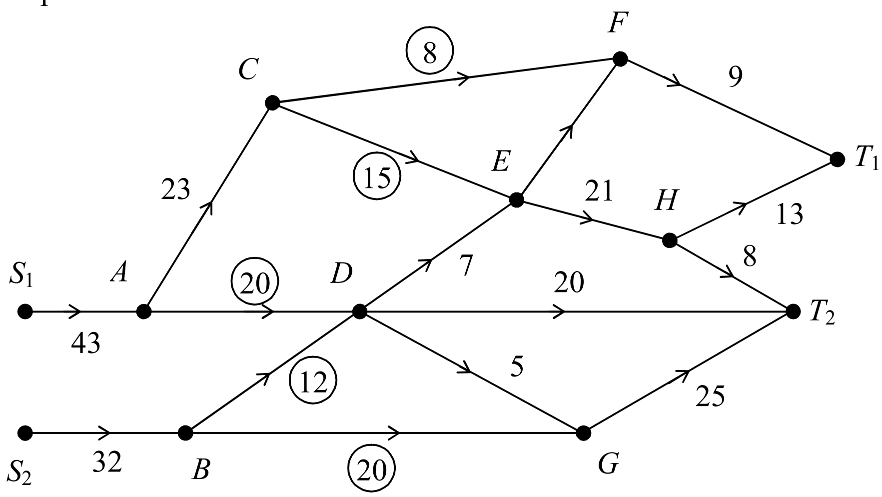
Question number	Mark scheme	Marks
1.	e.g. $C - 2 = A - 5 = E - 4$ cs $C = 2 - A = 5 - E = 4$	M1 A1
	$F - 1 = B - 3 = D - 6$ cs $F = 1 - B = 3 - D = 6$	M1 A1
	$\therefore A = 1$, $B = 3$, $C = 2$, $D = 6$, $E = 4$, $F = 1$	A1 (5)
		(5 marks)
2. (*a*)	Each arc contributes 2 to the sum of degrees, hence this sum must be even. Therefore there must be an even (or zero) number of vertices of odd degree.	B2, 1, 0 (2)
(*b*)	If $x > 9$, $10\frac{1}{2}x - 26 = 100$,	B1, M1 A1
	$\Rightarrow x = 12$	A1 (4)
	(If $x < 9$, $11\frac{1}{2}x - 35 = 100 \Rightarrow x = 11\frac{17}{23}$ inconsistent)	
		(6 marks)
3. (*a*)	For example: • In Prim the tree always 'grows' in a connected fashion; • In Kruskal the shortest arc is added (unless it completes a cycle), in Prim the nearest unattached vertex is added; • There is no need to check for cycles when using Prim; • Prim can be easily used when network given is matrix form	B3, 2, 1, 0 (3)
(*b*) (i)	Either *AC*, *AB*, *BD*, *BE*, *EF*, *EG* (if starts at *A* or *C*)	
	or *BD*, *BA*, *AC*, *BE*, *EF*, *EG* (if starts at *B* or *D*)	
	or *EF*, *EG*, *BE*, *BD*, *BA*, *AC* (if starts at *E* or *F*)	
	or *GE*, *EF*, *BE*, *BD*, *BA*, *AC* (if starts at *G*)	M1 A1
(ii)	*EF*, *AC*, *BD*, *BA*, *EG*, *BE*	M1 A1 (4)
		(7 marks)

Question number	Mark scheme	Marks
4. (*a*)	For example	
	$R \quad P \quad B \quad Y \quad T \quad \textcircled{K} \quad M \quad H \quad W \quad G$	M1 A1
	$B \quad \textcircled{H} \quad G \quad \boxed{K} \quad R \quad P \quad Y \quad \textcircled{T} \quad M \quad W$	A1 ft
	$B \quad \textcircled{G} \quad \boxed{H} \quad \boxed{K} \quad R \quad \textcircled{P} \quad M \quad \boxed{T} \quad Y \quad \textcircled{W}$	A1 ft
	$\textcircled{B} \quad \boxed{G} \quad \boxed{H} \quad \boxed{K} \quad \textcircled{M} \quad \boxed{P} \quad \textcircled{R} \quad \boxed{T} \quad \boxed{W} \quad \textcircled{Y}$	A1 ft (5)
	$B \quad G \quad H \quad K \quad M \quad P \quad R \quad T \quad W \quad Y$	
(*b*)	$\left[\frac{10+1}{2}\right] = 6$ Palmer; reject Palmer → Young	M1 A1
	$\left[\frac{5+1}{2}\right] = 3$ Halliwell; reject Boase → Halliwell	A1
	$\left[\frac{4+5}{2}\right] = 5$ Morris; reject Morris	
	List reduces to Kenney – name found, search complete	A1 (4)
		(9 marks)

Question number	Mark scheme	Marks
5. (*a*)		M1 A1 A1 A1 (4)
(*b*)	*A*, *C*, *G*, *H*, *J*, *K*, *L*	M1 A1 (2)
(*c*)	35 – 17 – 14 = 4	M1 A1 (2)
(*d*)	$226 \div 87 = 2.6$ (1 dp), $\therefore$ 3 workers	M1 A1 (2)
(*e*)	For example: 	M1 A1 A1 A1
	Worker 1: *A C G H K* Worker 2: *B E I J L* Worker 3: *D F M* New shortest time is 89	A1 (5)
		(15 marks)

Question number	Mark scheme	Marks
6. (*a*)	$(P =)\ 300x + 500y$	B1
(*b*)	Finishing $3.5x + 4y \le 56 \Rightarrow 7x + 8y \le 112$ (or equivalent)	B1
	Packing $2x + 4y \le 40 \Rightarrow x + 2y \le 20$ (or equivalent)	B1 (3)
(*c*)		B4, 3, 2, 1, 0 (4)
	(NB: The graph prints OK on my machine, but looks wrong on screen)	

Question number	Mark scheme	Marks
6. (*d*)	For example:	
(cont.)	*Point testing:* test all (5) points in feasible region find profit at each and select point yielding maximum	B1
	Profit line: draw profit lines with gradient $-\frac{3}{5}$ select point on profit line furthest from the origin	B1 (2)
(*e*)	Optimal point is (6, 7); make 6 Oxford and 7 York	M1; A1 ft
	Profit = £5300	A1 ft (3)
(*f*)	The line $3.5x + 4y = 49$ passes through (6, 7) so reduce finishing by 7 hours	M1 A1 ft A1
		(3)
		(15 marks)

Question number	Mark scheme	Marks
7. (*a*)	Adds *S* and *T* and arcs	M1
	$SS_1 \geq 45,\ SS_2 \geq 35,\ T_1T \geq 24,\ T_2T \geq 58$	A1 (2)
(*b*)	Using conservation of flow through vertices $x = 16$ and $y = 7$	B1 B1 (2)
(*c*)	$C_1 = 86,\ C_2 = 81$	B1 B1 (2)
(*d*)		M1 A1 M1
	e.g. $S\,S_1\,A\,D\,E\,H\,T_2\,T - 2$	A1
	$S\,S_1\,A\,C\,F\,E\,H\,T_1\,T - 3$	A1
	$S\,S_2\,B\,G\,D\,T_2\,T - 2$	A1 (6)
(*e*)	For example: 	M1 A1
	Flow 75	A1 (3)
(*f*)	Max flow – min cut theorem cut through *CF*, *CE*, *AD*, *BD*, *BG* (value 75)	M1 A1 (2)
		(18 marks)