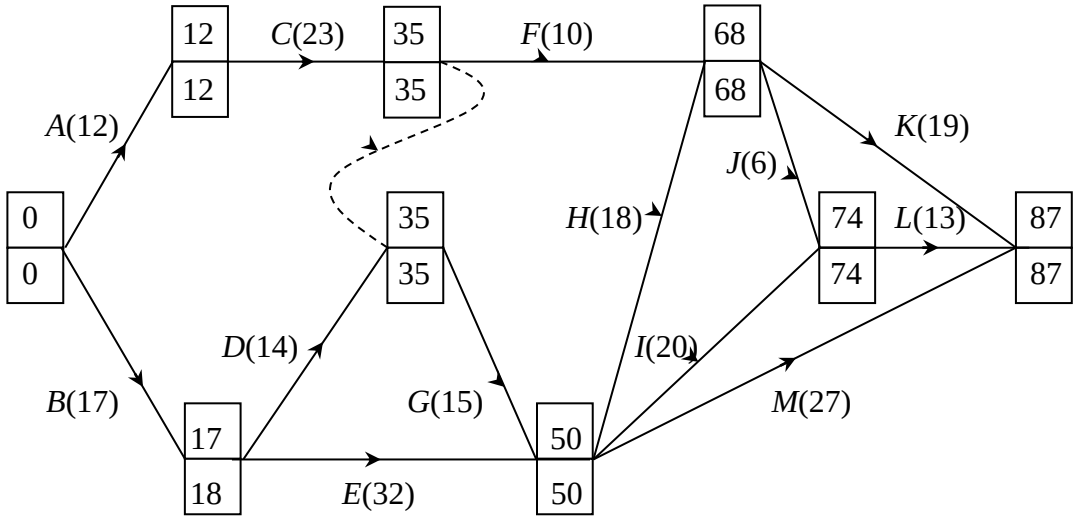
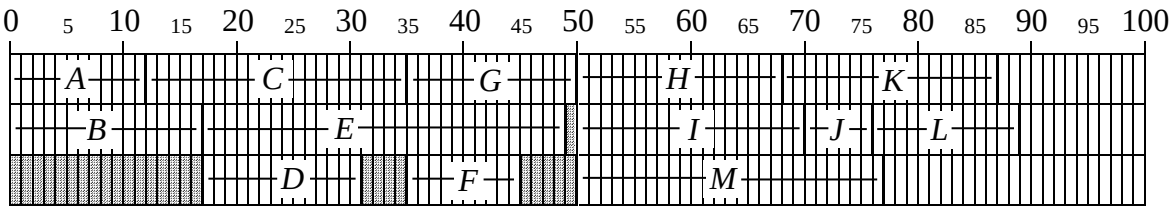
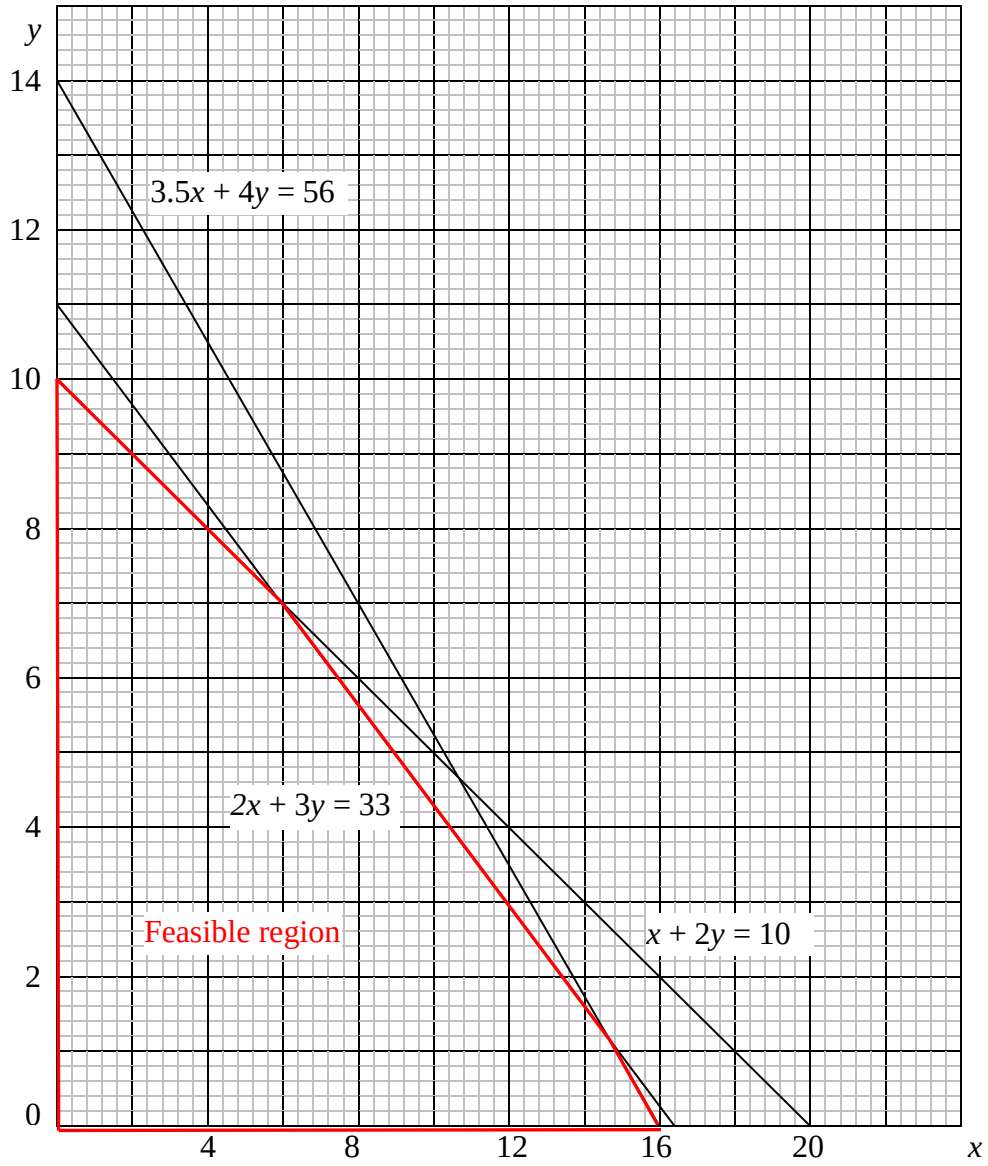
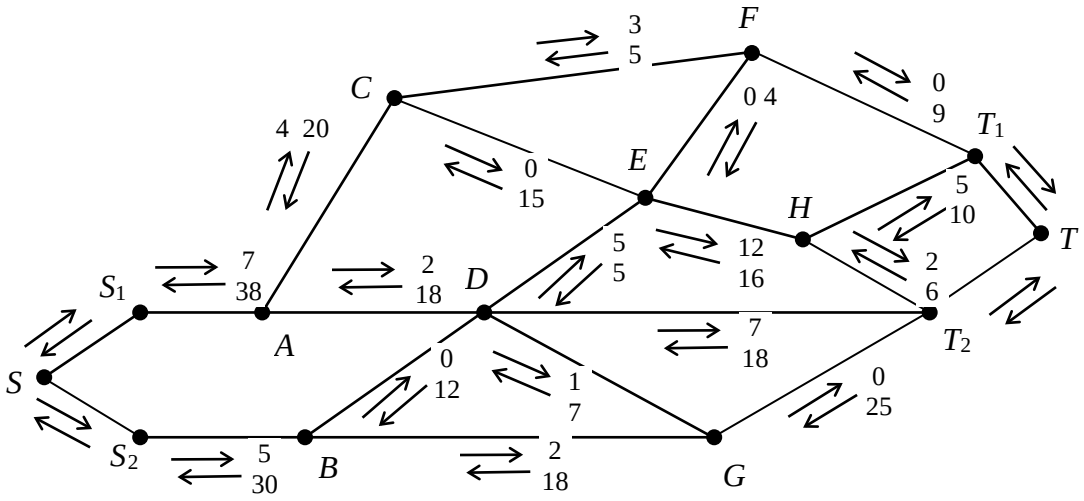
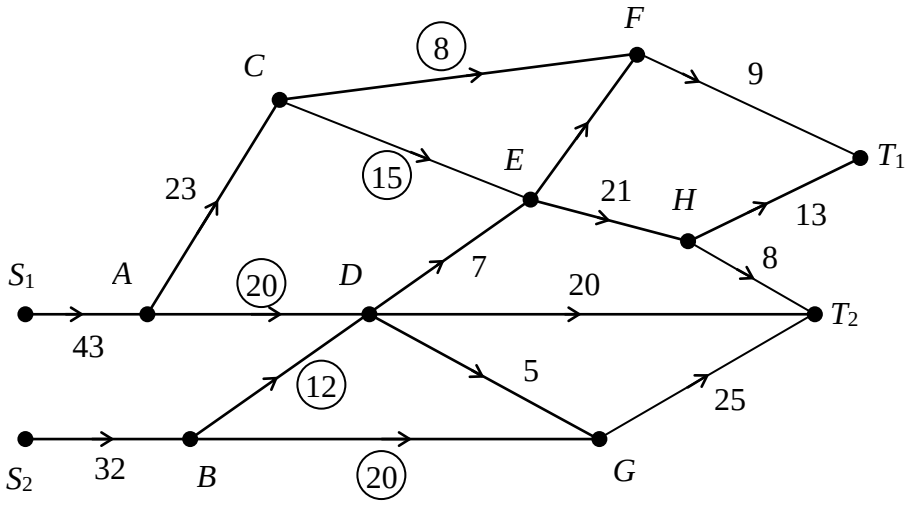
Question number	Mark scheme	Marks
1.	e.g. $C - 2 = A - 5 = E - 4$ cs $C = 2 - A = 5 - E = 4$ $F - 1 = B - 3 = D - 6$ cs $F = 1 - B = 3 - D = 6$ $\therefore A = 1$, $B = 3$, $C = 2$, $D = 6$, $E = 4$, $F = 1$	M1 A1 M1 A1 A1 (5) **(5 marks)**
2. (a)	Each arc contributes 2 to the sum of degrees, hence this sum must be even. Therefore there must be an even (or zero) number of vertices of odd degree.	B2, 1, 0 (2)
(b)	If $x > 9$, $10\frac{1}{2}x - 26 = 100$, $\Rightarrow x = 12$ (If $x < 9$, $11\frac{1}{2}x - 35 = 100 \Rightarrow x = 11\frac{17}{23}$ inconsistent)	B1, M1 A1 A1 (4) **(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 P B Y T (*K*) *M H W G*	M1 A1
	B (*H*) *G* [*K*] *R P Y* (*T*) *M W*	A1 ft
	B (*G*) [*H*] [*K*] *R* (*P*) *M* [*T*] *Y* (*W*)	A1 ft
	(*B*) [*G*] [*H*] [*K*] (*M*) [*P*] (*R*) [*T*] [*W*] (*Y*)	A1 ft (5)
	B G H K M P R T W Y	
(*b*)	$\left\lceil \frac{10+1}{2} \right\rceil = 6$ Palmer; reject Palmer $\rightarrow$ Young	M1 A1
	$\left\lceil \frac{5+1}{2} \right\rceil = 3$ Halliwell; reject Boase $\rightarrow$ Halliwell	A1
	$\left\lceil \frac{4+5}{2} \right\rceil = 5$ 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 ÷ 87 = 2.6 (1 dp), ∴ 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 $3.5x + 4y \leq 56 \Rightarrow 7x + 8y \leq 112$ (or equivalent)	B1
	Packing $2x + 4y \leq 40 \Rightarrow x + 2y \leq 20$ (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*) (cont.)	For example:	
	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)