D2 Paper F – Marking Guide

1. e.g. using stage, state approach:

Stage	State	Destination	Cost	Total cost
1	Marquee	Deluxe Cuisine	20 24	20* 24
	Castle	Deluxe Castle Cuisine	21 15 22	21 15* 22
	Hotel	Deluxe Cuisine Hotel	18 23 19	18* 23 19
2	Church	Marquee Castle Hotel	2 5.5 3	2 + 20 = 22 5.5 + 15 = 20.5* 3 + 18 = 21
	Castle	Marquee Castle	3 5	3 + 20 = 23 5 + 15 = 20*
	Registry Office	Marquee Castle Hotel	3.5 6 2	3.5 + 20 = 23.5 6 + 15 = 21 2 + 18 = 20*
3	Home	Castle Church Registry	3 5 1	3 + 20.5 = 23.5 5 + 20 = 25 1 + 20 = 21*

M1 A1

M1 A2

A1

minimum cost £2100 using
ceremony – Registry Office, reception – Hotel, catering – Deluxe A1 **(7)**

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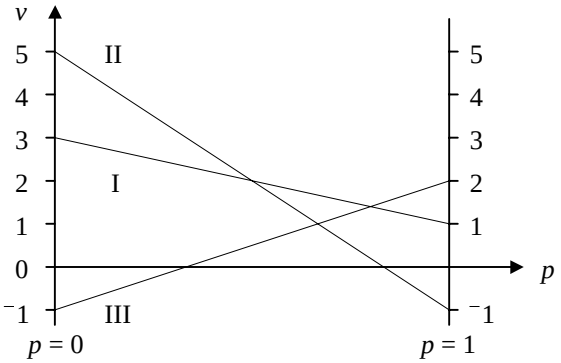
2. *(a)* let *A* play strategies I and II with proportions p and $(1 - p)$

expected payoff to *A* against each of *B*'s strategies:

B I $p + 3(1 - p) = 3 - 2p$
B II $\bar{}p + 5(1 - p) = 5 - 6p$
B III $2p - (1 - p) = 3p - 1$

M1 A1

giving



M1 A1

it is not worth player *B* considering strategy I A1

(b) for optimal strategy $5 - 6p = 3p - 1$ M1

$\therefore 9p = 6,\ p = \frac{2}{3}$

$\therefore$ *A* should play I $\frac{2}{3}$ of time and II $\frac{1}{3}$ of time A1

value of game $= 5 - (6 \times \frac{2}{3}) = 1$ A1 **(8)**

3.

					row min.
	5	20	12	18	5
	6	18	15	16	6
	4	21	9	15	4
	5	16	11	13	5

reducing rows gives:

	0	15	7	13
	0	12	9	10
	0	17	5	11
	0	11	6	8
col min.	0	11	5	8

M1 A1

reducing columns gives:

0	4	2	5	
0	1	4	2	
~~0~~	~~6~~	~~0~~	~~3~~	(N.B. a different choice of lines will lead to the same final assignment)
~~1~~	~~0~~	~~1~~	~~0~~	

A1

3 lines required to cover all zeros, apply algorithm — B1

0^*	3	1	4	
~~0~~	~~0^*~~	~~3~~	~~1~~	
~~1~~	~~6~~	~~0^*~~	~~3~~	
~~2~~	~~0~~	~~1~~	~~0^*~~	

M1 A1

4 lines required to cover all zeros so allocation is possible — B1

Andrew reviews a film
Betty reviews a musical
Carlos reviews a ballet — A1
Davina reviews a concert

total cost = 5 + 18 + 9 + 13 = £45 — A1 **(9)**

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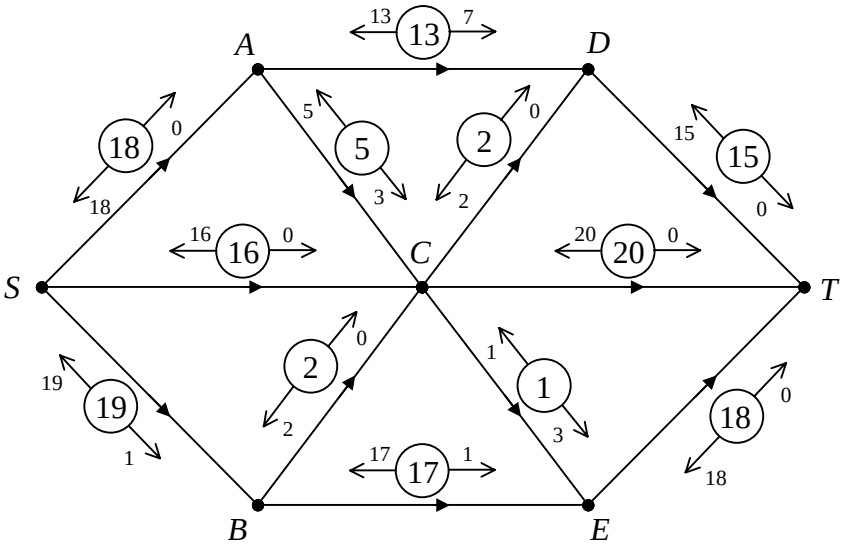
4. *(a)* $x = 2,\ y = 14$ — B2

(b) (i), (ii) e.g. augment *SCT* by 2 and *SBECADT* by 3 giving:



maximum flow = 53 — M2 A3

(c) (i) minimum cut = 53, passing through *DT*, *CT* and *ET* — B1

(ii) max flow = min cut
it is not possible to get any more flow across this cut — B1 **(9)**

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5. *(a)* maximise $R = 10x + 12y + 8z$ given

$x + 2y + 4z \leq 20$

$4x + 3y + 14z \leq 75$

$5x + 2y + 10z \leq 60$

$x \geq 0,\ y \geq 0,\ z \geq 0$ M1 A1

(b) to change inequalities into equations B1

(c) θ values are 10, 25 and 30 so pivot row is 2nd row

2nd tableau is:

R	x	y	z	s	t	u	
1	$^{-}4$	0	16	6	0	0	120
0	$\frac{1}{2}$	1	2	$\frac{1}{2}$	0	0	10
0	$\frac{5}{2}$	0	8	$-\frac{3}{2}$	1	0	45
0	4	0	6	$^{-}1$	0	1	40

M2 A2

choose to increase x next

θ values are 20, 18 and 10 so pivot row is 4th row

3rd tableau is:

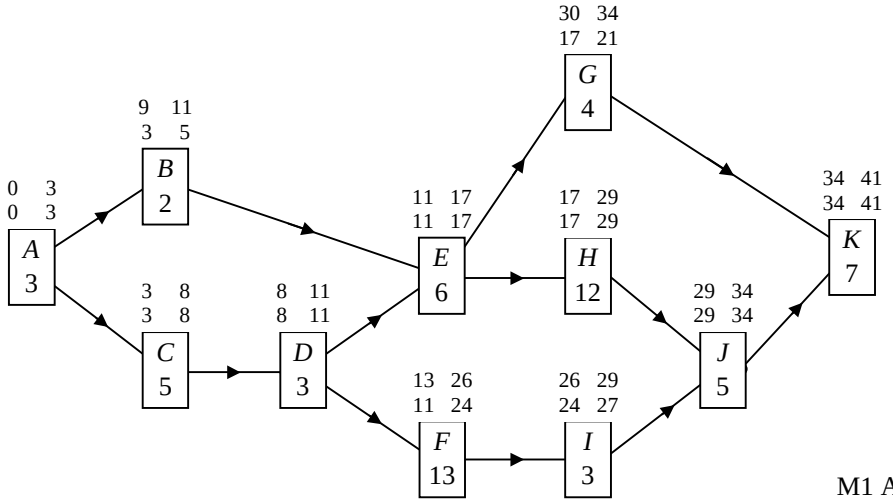
R	x	y	z	s	t	u	
1	0	0	22	5	0	1	160
0	0	1	$\frac{5}{4}$	$\frac{5}{8}$	0	$-\frac{1}{8}$	5
0	0	0	$\frac{17}{4}$	$-\frac{7}{8}$	1	$-\frac{5}{8}$	20
0	1	0	$\frac{3}{2}$	$-\frac{1}{4}$	0	$\frac{1}{4}$	10

M1 A2

(d) optimal solution as all values on the objective row are ≥ 0 B1

company donates 10 two-person and 5 four-person boats B1 **(12)**

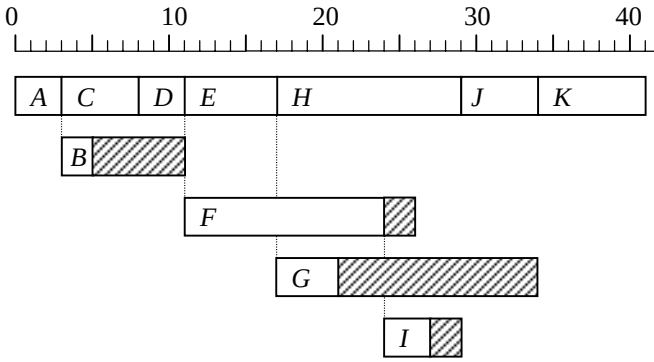
6. *(a)*



M1 A2

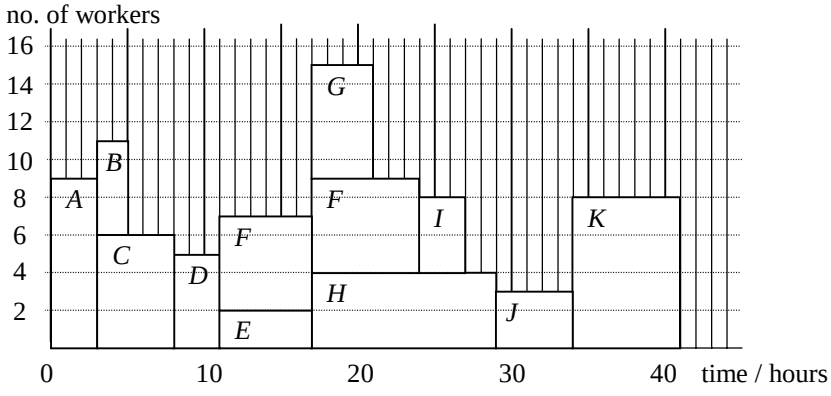
(b) lower figures give forward scan M1
upper figures give backward scan M1
critical path is *ACDEHJK* A1
minimum time is 41 hours A1

(c)



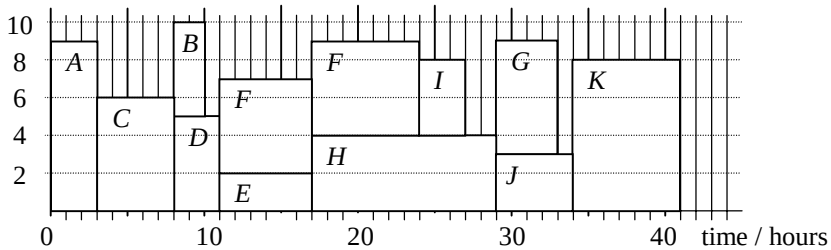
B3

(d) no. of workers



∴ max. of 15 workers required M1 A2

(e) no. of workers



M1 A1 **(15)**

Total **(60)**