5(a)	$PQSV$ has longest journey 12 $\rbrace$ $PQTV$ has longest journey 13				B1			Both of these
	Since 12 < 13, $PQSV$ is better				E1		2	OE

(b)

Stage	State	Action	Calculation	Value		
1	S	SV	-	11	$\rbrace$ B1	
	T	TV	-	9		
	U	UV	-	12		
2	Q	QS	Max (12, 11)	12	M1	2 values correct
		QT	Max (13, 9)	13		
		QU	Max (7, 12)	12	A1	All correct with pairs of correct values compared in calculation column
	R	RS	Max (10, 11)	11	M1	2 values correct
		RT	Max (14, 9)	14		
		RU	Max (8, 12)	12	A1	All correct with pairs of correct values compared to calculation column
3	P	PQ	Max (9, 12)	12	A1	CSO; all table correct With word "MAX" seen at least once (or 12 >11 etc)
		PR	Max (11, 11)	11		

Using their minimum at stage 3	M1		Implied by route starting PR (Or PQ if that is their least value)
Minimax route from P to V is $PRSV$	A1	8	SC B1 for correct minimax route when several values in table are incorrect

		Total		10	

Network approach: Use same mark scheme for 6 marks insisting on precisely these values, pairs of correct values **seen** and considered with maximum selected for first two A marks, and word 'Max' seen and all correct for final A mark

5(a)								

					Stage	State	From	Value	
					1	*I*	*T*	−7	
						J	*T*	−6	
						K	*T*	−5	
	Completing stage 2 values (condone correct unsimplified) (all 7 values)	B1			2	*E*	*I*	−7 − 4 = −11	←
						F	*I*	−7 − 3 = −10	←
							J	−6 − 2 = −8	
						G	*I*	−7 + 4 = −3	
							J	−6 + 7 = 1	
							K	−5 − 1 = −6	←
						H	*K*	−5 + 4 = −1	←
	At least 6 values calculated at stage 3 (M0 for 10 or more values)	M1			3	*A*	*E*	−11 + 5 = −6	
							G	−6 − 2 = −8	←
	Using only their minimum *F* or *G* value from stage 2	m1				*B*	*E*	−11 − 2 = −13	
							F	−10 − 4 = −14	←
						C	*F*	−10 + 6 = −4	
							G	−6 − 3 = −9	←
	All 9 stage 3 values correct	A1					*H*	−1 − 5 = −6	
						D	*G*	−6 − 5 = −11	←
							H	−1 − 3 = −4	
	Using minima (at least 3) from *A, B, C, D* stage 3 in stage 4	M1			4	*S*	*A*	−8 + 23 = 15	
							B	−14 + 28 = 14	←
							C	−9 + 25 = 16	
	All correct in stage 4	A1	6				*D*	−11 + 25 = 14	←
(b)	Minimum cost of ticket (£)14	B1✓		ft their lowest stage 4 value					
	Path *S B F I T*	B1		one correct path					
	S D G K T	B1	3	2nd correct path and no others					
	Total		9						

6	Wednesday profits	M1		4 more calculations/ profits correct
		A1		6 more profits correct
		A1		all profits correct
	Tuesday: use of maxima from Wednesday	M1		6 more calculations/profits correct
		A1		8 profits correct
		A1✓		all profits correct
				ft one slip from Wednesday figures
	Monday values correct	A1✓		all profits correct
				ft one slip from Tuesday figures
	(Monday builds shed) D	M1		Choosing largest Monday profit from their table
	$\Rightarrow$ order $D\ B\ A\ C$	A1cso	9	
				SC B1 only for order $D\ B\ A\ C$ NMS or without "correct" table

Stage (Day)	State (Sheds already built)	Action (shed to build)	Calculation	Profit in pounds	
Thursday	A, B, C	D		90	
	A, B, D	C		87	
	A, C, D	B		76	
	B, C, D	A		70	
Wednesday	A, B	C	84 + 90	174	
		D	88 + 87	175	→
	A, C	B	71 + 90	161	→
		D	82 + 76	158	
	A, D	B	74 + 87	161	→
		C	83 + 76	159	
	B, C	A	65 + 90	155	
		D	86 + 70	156	→
	B, D	A	69 + 87	156	→
		C	85 + 70	155	
	C, D	A	66 + 76	142	
		B	73 + 70	143	→
Tuesday	A	B	72 + 175	247	→
		C	83 + 161	244	
		D	84 + 161	245	
	B	A	60 + 175	235	
		C	80 + 156	236	
		D	83 + 156	239	→
	C	A	57 + 161	218	
		B	68 + 156	224	
		D	85 + 143	228	→
	D	A	62 + 161	223	
		B	70 + 156	226	→
		C	81 + 143	224	
Monday	-	A	50 + 247	297	
		B	65 + 239	304	
		C	70 + 228	298	
		D	80 + 226	306	→

Schedule

	Monday	Tuesday	Wednesday	Thursday
Shed to build	D	B	A	C

	Total		9	

JAN 2012

Stage	State	From	Calculation				
1	G	T		15			
	H	T		17	B1		stage 1 correct
	I	T		26			
2	D	G	6 + 15	21 ←			
		H	3 + 17	20			
	E	G	−3 + 15	12	M1		7 values at stage 2 attempted
		H	−6 + 17	11			with 5 unsimplified calculations correct
		I	−13 + 26	13 ←			
	F	H	−7 + 17	10			
		I	−14 + 26	12 ←	A1		stage 2 correct
3	A	D	−4 + 21	17	M1		use of two of "their" maxima from
		E	6 + 13	19 ←			Stage 2 to Stage 3
	B	D	12 + 21	33 ←			
		E	16 + 13	29			
		F	18 + 12	30			
	C	E	14 + 13	27 ←			
		F	13 + 12	25	A1		stage 3 correct
4	S	A	12 + 19	31*			
		B	−2 + 33	31*			
		C	3 + 27	30	A1cso	6	stage 4 & all other values correct

(b) Maximum profit = 31 — B1√ — £31 million

S A E I T and *S B D G T* — B1 — one correct path
B1 — 3 — second correct path and no other

Total — 9

JUNE 2012

5(a)(i)	(*BAC* : 70 , 55 , 75) Least annual cost = 55	B1		£55 000	
(ii)	*ABC* (involves costs 60 , 75 , 75) Least annual cost = 60	B1		£60 000	
	ABC is better, since 60 > 55	E1	3	statement & reason with both least annual costs correct	

(b)   **Year 3**   75 , 80 , 60

Year 2		Calc	Value			
		min (75 , 75)	75	←		
		min (70 , 80)	70		M1	Finding minima for 4 of "their" pairs in Year 2
		min (55 , 75)	55		A1	4 correct comparisons seen in Year 2
		min (60 , 60)	60	←		
		min (65 , 80)	65	←		
		min (80 , 60)	60		A1	all values correct **and** comparison figures shown and correct for Years 2 and 3
Year 1						
	A	min (60 , 75)	60		m1	choosing all "their" maxima from Year 2 and all "their" comparisons correct
	B	min (70 , 60)	60			
	C	min (65 , 65)	65	←	A1cso	all correct and word "**minimum**" seen in working – (condone "min" seen once)

Optimum order is   ***CAB***   M1   order starting with their **maximum** value from **Year 1** in table
BUT maximin must have been attempted

                                    A1cso   7   correct order;
allow this A1cso if only error in table is omission of word "minimum"

SC B1 for *CAB* if no evidence of maximin from table (or network).

JAN 2013

7(a)	Stage	State	From	Value				
	1	G	I	15				
		H	I	12				
	--	--	--	--				
	2	E	G	15+15 = 30 ←				
			H	12+16 = 28	B1			Stage 2 values correct
		F	G	15+13=28				
			H	12+17= 29 ←				
	--	--	--	-- -- --				
	3	B	E	30+16 = 46				
		C	E	30+14 = 44 ←	M1			Calculating 4 values at stage 3
			F	29+12 = 41	m1			Using max values at E and F
		D	F	29+15 = 44	A1			All 4 values correct
	--	--	--	-- -- --				
	4	A	B	46+12 = 58				
			C	44+20= 64 ←				
					m1			Using max at C
			D	44+18 = 62	A1			All correct
					B1	7		Identifying 64 as maximum value
(b)	Route A C E G I				B1	1		
				Total		8		

JUNE 2013

4	Stage	State	From	Value				
	1	H	K	18				
		I	K	15	B1			All correct
		J	K	12				
	2	E	H	⑰	M1			7 values at stage 2
			I	15				
		F	H	⑮	m1			Choosing max at E, F, G (PI), but must be using maximin
			I	14				
			J	12				
		G	I	⑭	A1			All correct at stage 2
			J	12				
	3	B	E	11				
			F	⑬	m1			7 values at stage 3, must have scored M2 earlier
		C	E	12				
			F	13	A1			All correct at stage 3
			G	⑭				
		D	F	⑮				
			G	14				
	4	A	B	12				
			C	⑭	A1			All correct (whole table)
			D	13	B1			For 14 as final value indicated or stated
	Route A C G I K				B1	9		Or reverse

6(a)	Stage 2		B1		4 correct values
			M1		Choosing 2 'mins' out of 4 expressions
	Stage 3		m1		4 expressions
			A1		*EG* chosen
	Stage 4		m1		4 expressions, 1 in terms of x
	Stage 5		B1		Final value 48, indicated or stated
			A1	7	All correct (complete table)
(b)	$x + 41 = 48$		M1		Their $(x + 8 + k)$ = their (min)
	$x = 7$		A1	2	
(c)	*A B D G I K*		B1		
	A B E G I K		B1		
	A C F H I K		B1	3	Condone reverse (x3)
		Total		**12**	

Stage	State	From	Calculation	Value
1	*I*	*K*	12	12
	J	*K*	14	14
2	*G*	*I*	$15 + 12$	27
		J	$14 + 14$	(28)
	H	*I*	$12 + 13$	25
		J	$14 + 12$	(26)
3	*D*	*G*	$27 + x + 2$	$29 + x$
	E	*G*	$27 + 9$	36
		H	$25 + 12$	(37)
	F	*H*	$25 + 13$	38
4	*B*	*D*	$29 + x + 4$	$33 + x$
		E	$36 + 4$	40
	C	*E*	$36 + 9$	(45)
		F	$38 + 6$	44
5	*A*	*B*	$33 + x + 8$	$41 + x$
		B	$40 + 8$	48
	A	*C*	$44 + 4$	48