OCR
RECOGNISING ACHIEVEMENT

GCE

Mathematics (MEI)

Advanced GCE **4772**

Decision Mathematics 2

Mark Scheme for June 2010

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1.

(a)(i) $\sim c \Rightarrow e$	B1	
(ii) $(c \Rightarrow \sim e) \Leftrightarrow (\sim c \Rightarrow e)$ 1 0 01 0 01 1 1 or 0 1 10 0 10 0 0	M1 A1 M1 A1	line of a TT both propositions 1 or both 0 an "$\Rightarrow$" correct all OK
(b)(i) Circuit is $\sim x \vee y$. This is $x \Rightarrow y$. 10 1 0 0 1 0 10 1 1 0 1 1 01 0 0 1 0 0 01 1 1 1 1 1	B1 B4	
(ii) $(\sim p \wedge \sim q) \Rightarrow r$	M1 A1	implication noted
(iii) $(\sim p \wedge \sim q) \Rightarrow r$ is equivalent to $\sim r \Rightarrow \sim(\sim p \wedge \sim q)$	B1	
But we have $\sim r$, so we have $\sim(\sim p \wedge \sim q)$.	B1	
$\sim(\sim p \wedge \sim q)$ is equivalent to $p \vee q$	B1	
But we have $\sim q$, so therefore p.	B1	

2.

(i) Distances longer — B1

(ii)

	1	2	3	4	5	6			1	2	3	4	5	6
1	∞	15	∞	∞	7	8		**1**	1	2	3	4	5	6
2	15	∞	6	2	6	∞		**2**	1	2	3	4	5	6
3	∞	6	∞	3	∞	∞		**3**	1	2	3	4	5	6
4	∞	2	3	∞	10	17		**4**	1	2	3	4	5	6
5	7	6	∞	10	∞	8		**5**	1	2	3	4	5	6
6	8	∞	∞	17	8	∞		**6**	1	2	3	4	5	6

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	∞	15	∞	∞	7	8		**1**	1	2	3	4	5	6
2	15	30	6	2	6	23		**2**	1	1	3	4	5	1
3	∞	6	∞	3	∞	∞		**3**	1	2	3	4	5	6
4	∞	2	3	∞	10	17		**4**	1	2	3	4	5	6
5	7	6	∞	10	14	8		**5**	1	2	3	4	1	6
6	8	23	∞	17	8	16		**6**	1	1	3	4	5	1

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	30	15	21	17	7	8		**1**	2	2	2	2	5	6
2	15	30	6	2	6	23		**2**	1	1	3	4	5	1
3	21	6	12	3	12	29		**3**	2	2	2	4	2	2
4	17	2	3	4	8	17		**4**	2	2	3	2	2	6
5	7	6	12	8	12	8		**5**	1	2	2	2	2	6
6	8	23	29	17	8	16		**6**	1	1	1	4	5	1

M1 30 in top left
A1 times
A1 6 to 3 route = 1
A1 rest of route

	1	2	3	4	5	6			1	2	3	4	5	6
1	30	15	21	17	7	8		**1**	2	2	2	2	5	6
2	15	12	6	2	6	23		**2**	1	3	3	4	5	1
3	21	6	12	3	12	29		**3**	2	2	2	4	2	2
4	17	2	3	4	8	17		**4**	2	2	3	2	2	6
5	7	6	12	8	12	8		**5**	1	2	2	2	2	6
6	8	23	29	17	8	16		**6**	1	1	1	4	5	1

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	30	15	20	17	7	8		**1**	2	2	2	2	5	6
2	15	4	5	2	6	19		**2**	1	4	4	4	5	4
3	20	5	6	3	11	20		**3**	4	4	4	4	4	4
4	17	2	3	4	8	17		**4**	2	2	3	2	2	6
5	7	6	11	8	12	8		**5**	1	2	2	2	2	6
6	8	19	20	17	8	16		**6**	1	4	4	4	5	1

not part of answer

	1	2	3	4	5	6			1	2	3	4	5	6
1	14	13	18	15	7	8		**1**	5	5	5	5	5	6
2	13	4	5	2	6	14		**2**	5	4	4	4	5	5
3	18	5	6	3	11	19		**3**	4	4	4	4	4	4
4	15	2	3	4	8	16		**4**	2	2	3	2	2	2
5	7	6	11	8	12	8		**5**	1	2	2	2	2	6
6	8	14	19	16	8	16		**6**	1	5	5	5	5	1

not part of answer

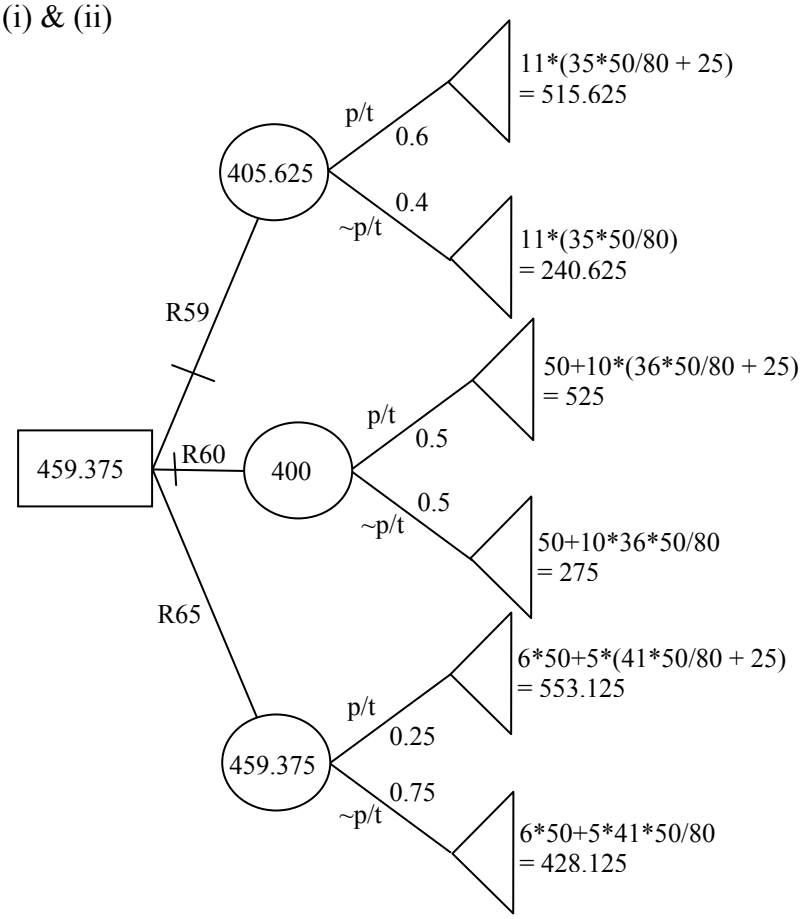
	1	2	3	4	5	6			1	2	3	4	5	6
1	14	13	18	15	7	8		**1**	5	5	5	5	5	6
2	13	4	5	2	6	14		**2**	5	4	4	4	5	5
3	18	5	6	3	11	19		**3**	4	4	4	4	4	4
4	15	2	3	4	8	16		**4**	2	2	3	2	2	2
5	7	6	11	8	12	8		**5**	1	2	2	2	2	6
6	8	14	19	16	8	16		**6**	1	5	5	5	5	1

not part of answer

(iii) cont It has found all shortest times and corresponding routes. Shortest time from x to y is in x row and y column of time matrix. For route look in x row and y column of route matrix. This gives first vertex "en route". Repeat, looking in row corresponding to the current "en route" vertex and the y column, until the "en route" vertex is y. Shortest time from 3 to 6 is 19. Corresponding route is 3 to 4 to 2 to 5 to 6.	 B1 B1 B1 B1 B1
(iv) On time matrix – 1(7)5(6)2(2)4(3)3(19)6(8)1 so 45 From route matrix – 1 5 2 4 3 4 2 5 6 1	B1 B1
(v) Lower bound = 7 + 8 + 19 = 34	M1 A1 7 + 8 A1 19
(vi) 82 + 8 = 90 minutes	B1

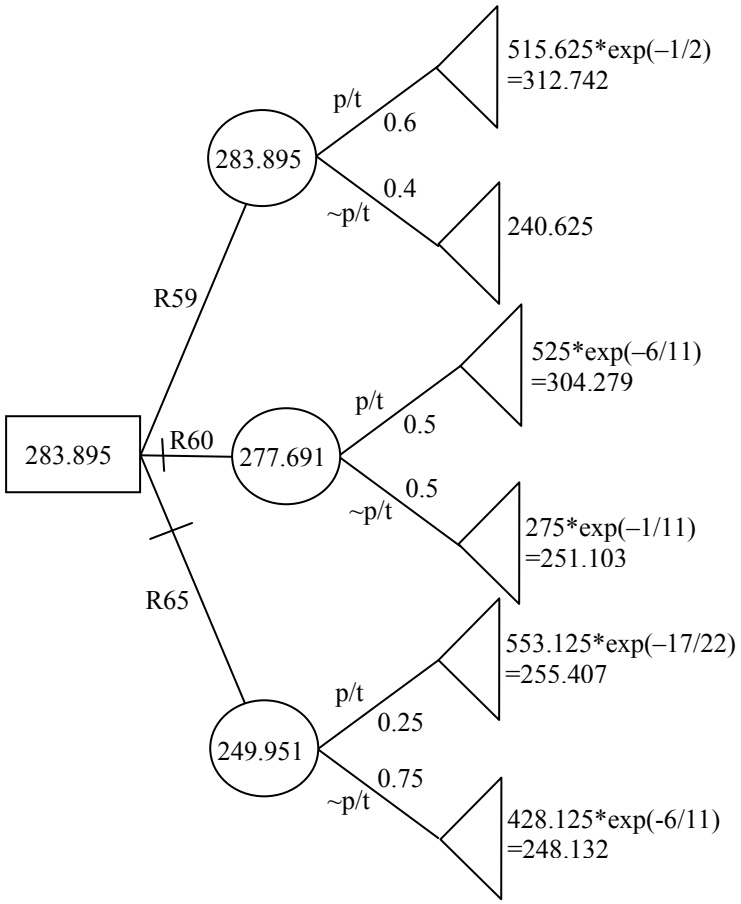
3.

(i) & (ii)



Retire at 65, EMV = 459375

M1	3-way split
A1	choice node
M1	2-way splits
A1	chance nodes
B1	pension calculations
M1	(income + pension) × time
A1	retire at 59
A1	retire at 60
A1	retire at 65
M1	EMV's
A1√	
M1	choice
A1√	

(iii) p's (in order) $\frac{1}{2}$ 0 $\frac{6}{11}$ $\frac{1}{11}$ $\frac{17}{22}$ (given) $\frac{6}{11}$	M1 A1
	M1 final utilites A1 cao M1 expecteds A1 √
Retire at 59.	B1 choice

4.

(i) Max $180x + 90y + 110z$ B1
st $2x + 5y + 3z \leq 30$ B1
$4x + y + 2z \leq 24$ B1

(ii)

P	x	y	z	s1	s2	RHS	
1	–180	–90	–110	0	0	0	M1 initial tableau
0	2	5	3	1	0	30	A1
0	4	1	2	0	1	24	
1	0	–45	–20	0	45	1080	M1 first iteration
0	0	4.5	2	1	–0.5	18	A1
0	1	0.25	0.5	0	0.25	6	
1	0	0	0	10	40	1260	M1 second iteration
0	0	1	4/9	2/9	–1/9	4	A1
0	1	0	7/18	–1/18	5/18	5	

Identification of basic variables + values B1 B1

(iii) Over two weeks (x = 3 and z = 18) B1

(iv) Degeneracy (technical term not required) – objective planes are parallel to boundary line. B1 same obj value
B1 line of solutions

(v)

A	P	x	y	z	s1	s2	s3	s4	a	RHS	
1	0	1	1	0	0	0	0	–1	0	7	B1 = → ≤ + ≥
0	1	–180	–90	–110	0	0	0	0	0	0	B1 ≤ row
0	0	2	5	3	1	0	0	0	0	30	B1 ≥ row
0	0	4	1	2	0	1	0	0	0	24	B1 new objective
0	0	1	1	0	0	0	1	0	0	7	B1 minimise A
0	0	1	1	0	0	0	0	–1	1	7	

or

P	x	y	z	s1	s2	s3	s4	a	RHS	
1	–M–180	–M–90	–110	0	0		M	0	–7M	B1 = → ≤ + ≥
0	2	5	3	1	0	0	0	0	30	B1 ≤ row
0	4	1	2	0	1	0	0	0	24	B1 ≥ row
0	1	1	0	0	0	1	0	0	7	B1 new objective
0	1	1	0	0	0	0	–1	1	7	B1 maximise P

(vi) Point is on the line – gives £1260 profit B1 (either)

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