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

	1	**2**	**3**	**4**	**5**	**6**
1	1	2	3	4	5	6
2	1	2	3	4	5	6
3	1	2	3	4	5	6
4	1	2	3	4	5	6
5	1	2	3	4	5	6
6	1	2	3	4	5	6

not part of answer

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

	1	**2**	**3**	**4**	**5**	**6**
1	1	2	3	4	5	6
2	1	1	3	4	5	1
3	1	2	3	4	5	6
4	1	2	3	4	5	6
5	1	2	3	4	1	6
6	1	1	3	4	5	1

not part of answer

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

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

	1	**2**	**3**	**4**	**5**	**6**
1	2	2	2	2	5	6
2	1	3	3	4	5	1
3	2	2	2	4	2	2
4	2	2	3	2	2	6
5	1	2	2	2	2	6
6	1	1	1	4	5	1

not part of answer

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

	1	**2**	**3**	**4**	**5**	**6**
1	2	2	2	2	5	6
2	1	4	4	4	5	4
3	4	4	4	4	4	4
4	2	2	3	2	2	6
5	1	2	2	2	2	6
6	1	4	4	4	5	1

not part of answer

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

	1	**2**	**3**	**4**	**5**	**6**
1	5	5	5	5	5	6
2	5	4	4	4	5	5
3	4	4	4	4	4	4
4	2	2	3	2	2	2
5	1	2	2	2	2	6
6	1	5	5	5	5	1

not part of answer

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

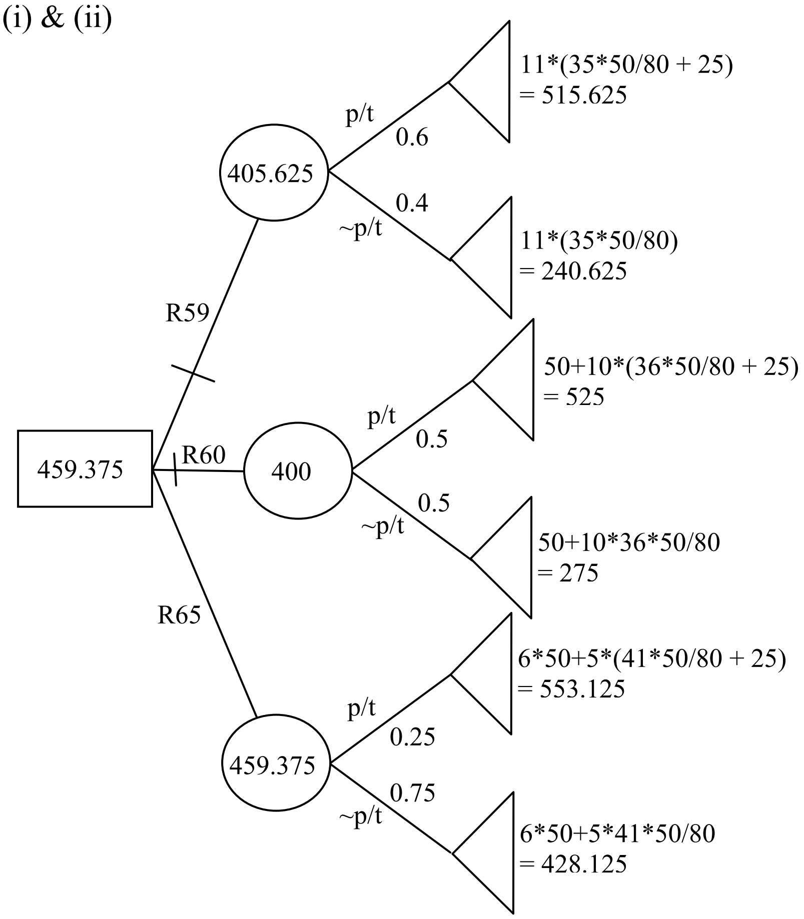
	1	**2**	**3**	**4**	**5**	**6**
1	5	5	5	5	5	6
2	5	4	4	4	5	5
3	4	4	4	4	4	4
4	2	2	3	2	2	2
5	1	2	2	2	2	6
6	1	5	5	5	5	1

not part of answer

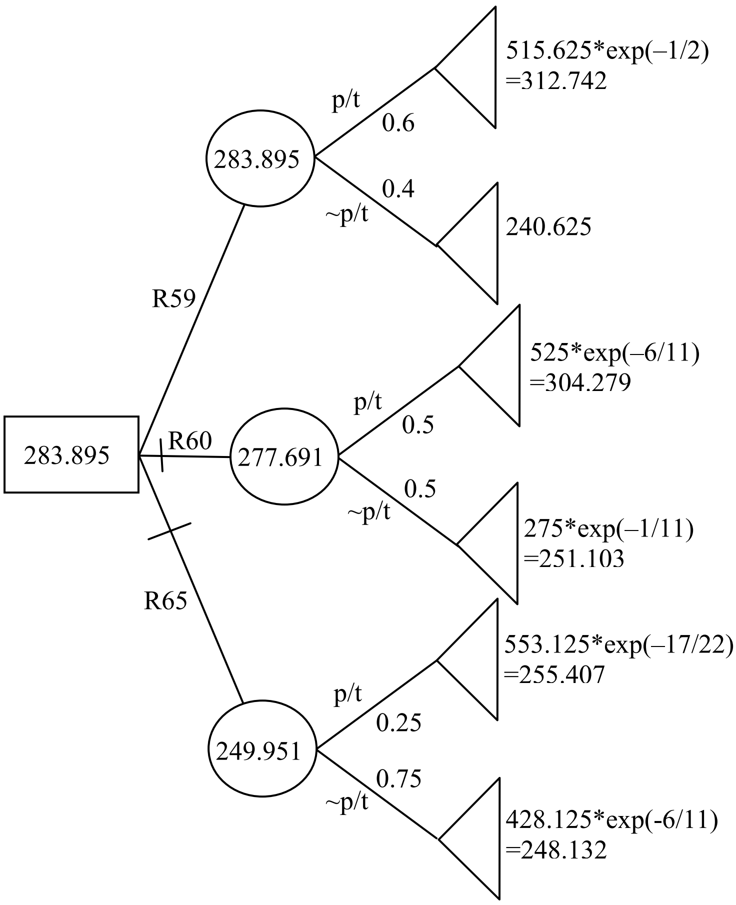
(iii) cont It has found all shortest times and corresponding routes. Shortest time from x to y is in x row and y column of time matrix. For route look in x row and y column of route matrix. This gives first vertex "en route". Repeat, looking in row corresponding to the current "en route" vertex and the 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)



(decision tree above)	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√	
Retire at 65, EMV = 459375	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
0	2	5	3	1	0	30
0	4	1	2	0	1	24
1	0	–45	–20	0	45	1080
0	0	4.5	2	1	–0.5	18
0	1	0.25	0.5	0	0.25	6
1	0	0	0	10	40	1260
0	0	1	4/9	2/9	–1/9	4
0	1	0	7/18	–1/18	5/18	5

M1 initial tableau
A1

M1 first iteration
A1

M1 second iteration
A1

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
0	1	–180	–90	–110	0	0	0	0	0	0
0	0	2	5	3	1	0	0	0	0	30
0	0	4	1	2	0	1	0	0	0	24
0	0	1	1	0	0	0	1	0	0	7
0	0	1	1	0	0	0	0	–1	1	7

B1 = → ≤ + ≥
B1 ≤ row
B1 ≥ row
B1 new objective
B1 minimise A

or

P	x	y	z	s1	s2	s3	s4	a	RHS
1	–M–180	–M–90	–110	0	0		M	0	–7M
0	2	5	3	1	0	0	0	0	30
0	4	1	2	0	1	0	0	0	24
0	1	1	0	0	0	1	0	0	7
0	1	1	0	0	0	0	–1	1	7

or

B1 = → ≤ + ≥
B1 ≤ row
B1 ≥ row
B1 new objective
B1 maximise P

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

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