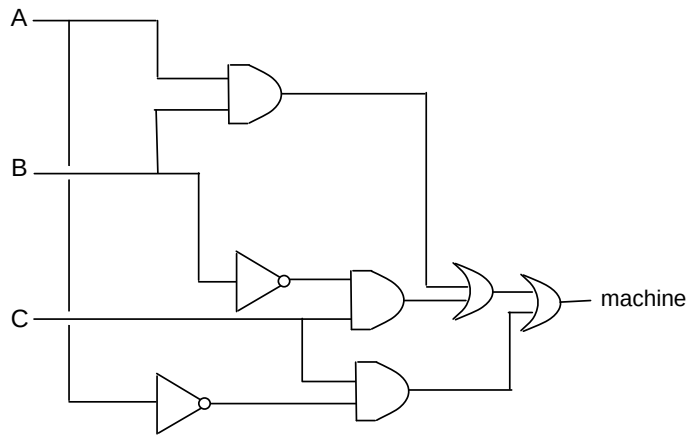
4772 Decision Mathematics 2

Question 1.

(a) e.g.
"It is easy to overestimate the effect that your contribution will make."

M1 remove double negatives
A1 same meaning

(b) e.g.



M1 combinatorial
A1 "ands"
A1 negations
A1 "ors"
A3 one for each alternative

(c) e.g.

((a	∧	b)	∨	(~a	∧	c))	∨	(~b	∧	c)
1	1	1	**1**	0	0	1	1	0	0	1
1	1	1	**1**	0	0	0	1	0	0	0
1	0	0	**0**	0	0	1	1	1	1	1
1	0	0	**0**	0	0	0	0	1	0	0
0	0	1	**1**	1	1	1	1	0	0	1
0	0	1	**0**	1	0	0	0	0	0	0
0	0	0	**1**	1	1	1	1	1	1	1
0	0	0	**0**	1	0	0	0	1	0	0

M1 8 lines
A1 a, b, c
A1 negations
A1 "and"s
A1 "or"s

~	((~a	∧	~c)	∨	(~b	∧	~c))
1	0	0	0	**0**	0	0	0
1	0	0	1	**0**	0	0	1
1	0	0	0	**0**	1	0	0
0	0	0	1	**1**	1	1	1
1	1	0	0	**0**	0	0	0
0	1	1	1	**1**	0	0	1
1	1	0	0	**0**	1	0	0
0	1	1	1	**1**	1	1	1

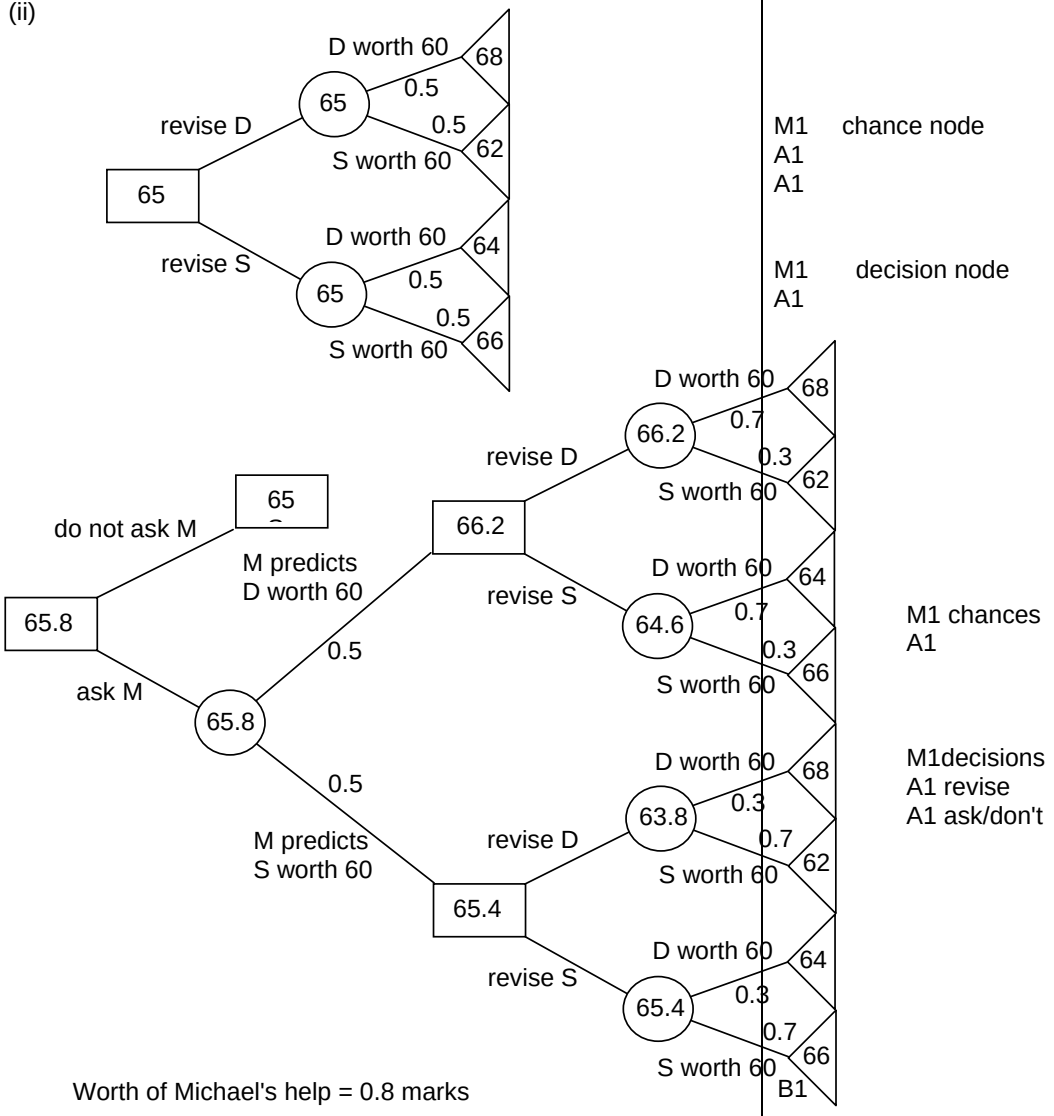
M1
A1

Question 2.

(i)

revised	60marks	score	
D	D	48+20 = 68	M1
D	S	32+30 = 62	A1
S	D	36+28 = 64	A1
S	S	24+42 = 66	A1
			A1

(ii)



M1 chance node
A1
A1

M1 decision node
A1

M1 chances
A1

M1decisions
A1 revise
A1 ask/don't

B1

Question 3.

(i) a is the number of acres of land put to crop A, etc — B1
$a + b \le 20$ is equivalent to $a + b \le c + d$ — B1
Given that $a + b + c + d \le 40$, the maximisation will ensure that $a + b + c + d = 40$ (and it's easier to solve using simplex). — B1

(ii)

P	a	b	c	d	s1	s2	RHS	
1	–50	–40	–40	–30	0	0	0	M1
0	1	1	0	0	1	0	20	A1
0	1	1	1	1	0	1	40	A1
1	0	10	–40	–30	50	0	1000	A1
0	1	1	0	0	1	0	20	M1 A1
0	0	0	1	1	–1	1	20	
1	0	10	0	10	10	40	1800	M1 A1
0	1	1	0	0	1	0	20	
0	0	0	1	1	–1	1	20	

20 acres to A and 20 acres to C, giving profit of £1800 — B1 B1

(iii) Max $50a + 40b + 40c + 30d$
st $a + b \le 20$
$a + b + c + d \le 40$
$a + b + c + d \ge 40$ — B1

A	P	a	b	c	d	s1	s2	sur	art	R	
1	0	1	1	1	1	0	0	–1	0	40	B1 new obj
0	1	–50	–40	–40	–30	0	0	0	0	0	B1 surplus
0	0	1	1	0	0	1	0	0	0	20	B1 artificial
0	0	1	1	1	1	0	1	0	0	40	
0	0	1	1	1	1	0	0	–1	1	40	B1 3 constraints

Minimise A (to zero) then drop A row and art column and continue normally — B1 B1

OR — **OR**

P	a	b	c	d	s1	s2	sur	art	R	
1	–50 –M	–40 –M	–40 –M	–30 –M	0	0	M	0	–40M	M1 A1
0	1	1	0	0	1	0	0	0	20	
0	1	1	1	1	0	1	0	0	40	B1 surplus
0	1	1	1	1	0	0	–1	1	40	B1 artificial

Proceed as per simplex, regarding M as a large fixed number. — B1 B1

Question 4.

(a) (i),(ii) and (iii)

	1	2	3	4	5
1	∞	22	∞	15	15
2	22	∞	20	5	23
3	∞	20	∞	40	∞
4	15	5	40	∞	16
5	15	23	∞	16	∞

	1	2	3	4	5
1	1	2	3	4	5
2	1	2	3	4	5
3	1	2	3	4	5
4	1	2	3	4	5
5	1	2	3	4	5

M1 distance
A1 1 to 5 etc
A1 rest

B1 route

	1	2	3	4	5
1	∞	22	∞	15	15
2	22	44	20	5	23
3	∞	20	∞	40	∞
4	15	5	40	30	16
5	15	23	∞	16	30

	1	2	3	4	5
1	1	2	3	4	5
2	1	1	3	4	5
3	1	2	3	4	5
4	1	2	3	1	5
5	1	2	3	4	1

Not part of the question

	1	2	3	4	5
1	44	22	42	15	15
2	22	44	20	5	23
3	42	20	40	25	43
4	15	5	25	10	16
5	15	23	43	16	30

	1	2	3	4	5
1	2	2	2	4	5
2	1	1	3	4	5
3	2	2	2	2	2
4	1	2	2	2	5
5	1	2	2	4	1

Not part of the question

	1	2	3	4	5
1	44	22	42	15	15
2	22	44	20	5	23
3	42	20	40	25	43
4	15	5	25	10	16
5	15	23	43	16	30

	1	2	3	4	5
1	2	2	2	4	5
2	1	1	3	4	5
3	2	2	2	2	2
4	1	2	2	2	5
5	1	2	2	4	1

Not part of the question

	1	2	3	4	5
1	30	20	40	15	15
2	20	10	20	5	21
3	40	20	40	25	41
4	15	5	25	10	16
5	15	21	41	16	30

	1	2	3	4	5
1	4	4	4	4	5
2	4	4	3	4	4
3	2	2	2	2	2
4	1	2	2	2	5
5	1	4	4	4	1

M1
A1 10 changed dists

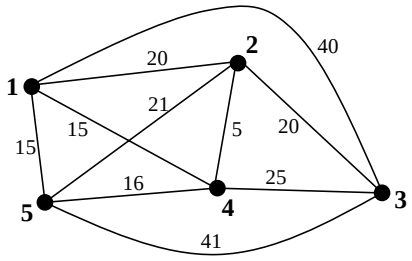
M1 2's in r3 of route
A1 rest of route

	1	2	3	4	5
1	30	20	40	15	15
2	20	10	20	5	21
3	40	20	40	25	41
4	15	5	25	10	16
5	15	21	41	16	30

	1	2	3	4	5
1	4	4	4	4	5
2	4	4	3	4	4
3	2	2	2	2	2
4	1	2	2	2	5
5	1	4	4	4	1

Shortest distance from **3** to **1** is 40
(1st row and 3rd column of distance matrix)

B1
B1

	Shortest route is **3 2 4 1** **3** followed by route matrix (3,1) = **2** followed by route matrix (2,1) = **4** followed by route matrix (4,1) = **1**	B1 M1 A1
(iv)		M1 A1
(v)	**2** (5) **4** (15) **1** (15) **5** (41) **3** (20) **2** Total length = 96	B1 B1
	2 4 1 5 (4 2) 3 2	M1 A1
	Finds a (hopefully short) route visiting every vertex and returning to the start, **or**, upper bound to the TSP	B1