OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary General Certificate of Education
Advanced General Certificate of Education

MATHEMATICS 4736

Decision Mathematics 1

MARK SCHEME

Specimen Paper

MAXIMUM MARK	72

This mark scheme consists of 4 printed pages.

Registered Charity Number: 1066969
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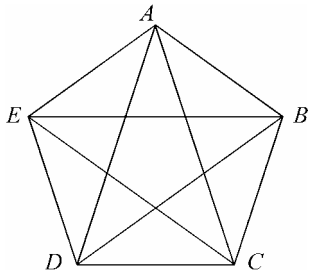
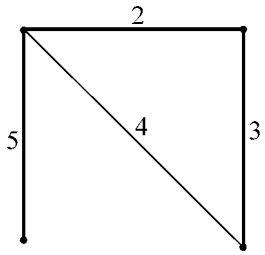
1	**(i)**				
			B1		For correct graph
		K_5 is Eulerian since every node is even	B1	**2**	For a correct statement
	(ii)	A path is (e.g.) *A–B–C*	B1	**1**	For any correct path
	(iii)	A cycle is (e.g.) *A–B–C–A*	B1	**1**	For any correct cycle
				4	
2	**(i)**	Using Kruskal's algorithm, the arc of least weight is chosen first and so is certainly included	B1		For identifying the first choice
		The arc of second least weight is chosen next	B1		For identifying the second choice
		since just two arcs cannot form a cycle	B1	**3**	For correct justification
	(ii)				
			B1		For any connected graph with 4 nodes and at least 3 arcs
			M1		For including a cycle
			A1		For a network having the required property
			A1	**4**	For making the minimum connector clear
				7	
3	**(i)**	1st pass: 6 3 8 3 2 giving 3 6 8 3 2	B1		For correct result of first pass
		2nd pass: 3 6 8 3 2 giving 3 6 8 3 2	B1		For correct result of second pass
		3rd pass: 3 6 8 3 2			
		3 6 3 8 2			
		3 3 6 8 2 giving 3 3 6 8 2	M1		For correct shuttle process in third pass
		4th pass: 3 3 6 8 2			
		3 3 6 2 8			
		3 3 2 6 8	M1		For correct shuttle process in final pass
		3 2 3 6 8 giving 2 3 3 6 8	A1	**5**	For shuttle sort completed correctly
	(ii)	The number of operations to be carried out, and thus the time to complete the algorithm, is	M1		For idea of dependency on 'size' of problem
		(approximately) proportional to the square of the	A1		For number of operations, or time required
		number of items to be sorted	A1	**3**	For square of list size
				8	

4 **(i)**

STEP	*A*	*B*	*C*
1	6	13	0
2	6	13	6
4	12	6	6
4	24	3	6
2	24	3	30
4	48	1	30
2	48	1	78
3	48	1	78
6	Output 78		

B1 For assigning value to *C* in first Step 2
M1 For updating *A* and *B* in first Step 4
M1 For continuing algorithm and updating *C*
A1 For correct new value 30 for *C*
A1 **5** For correct output

(ii)

STEP	*A*	*B*	*C*
1	*A*	8	0
4	2*A*	4	0
4	4*A*	2	0
4	8*A*	1	0
2	8*A*	1	8*A*
3	8*A*	1	8*A*
6	Output 8*A*		

M1 For values of *A* doubling
M1 For values of *B* halving
A1 For output 8*A*

The output is the product of the inputs
B1 **4** For identifying multiplication

9

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5 **(i)** A minimum connector on reduced network has arcs *CE*, *ED*, *BD*, *AB*, giving length 23 km
M1 For attempt at a relevant minimum connector
A1 For correct weight 23
Two shortest arcs from *F* have weights 7, 8
M1 For identifying the two shortest arcs at *F*
Hence lower bound is $23+7+8=38$ km
A1 **4** For showing given answer correctly

(ii) The best upper bound is 47 km
B1 For the correct answer
The best lower bound is 40 km
B1 **2** For the correct answer

(iii) Other orders are *CED*, *DCE*, *DEC*, *ECD*, *EDC*
M1 For calculation of at least one other length
Shortest is *ABDCEFA*, of length 42 km
A1 For any correct bound less than 47 km
A1 **3** For the correct value 42

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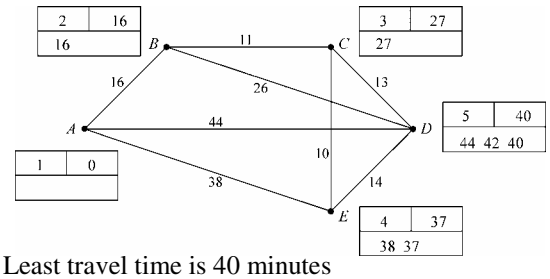
6 **(i)**



M1 For correct use of temporary labels
M1 For updating *E* and *D*
A1 For all permanent labels correct
B1 For correct order of assignment stated

Least travel time is 40 minutes
B1 For correct value 40
Route is *A*–*B*–*C*–*D*
B1 **6** For correct route

(ii) The Route Inspection algorithm is used
B1 For stating or implying the correct algorithm
A, *B*, *C* and *E* are odd nodes
B1 For identifying the odd nodes
$AB=16 \quad AC=27 \quad AE=37$
$CE=\underline{10}\ \underline{26} \quad BE=\underline{21}\ \underline{48} \quad BC=\underline{11}\ \underline{48}$
M1 For pairing odd nodes correctly
Double up on *AB* and *CE*
M1 For selecting appropriate pair for doubling
Sum of arcs is 172
M1 For adding weights on all the arcs
Hence shortest time is $172+26=198$ minutes
A1 **6** For correct value 198

(iii) Nearest neighbour algorithm gives *A*–*B*–*C*–*E*–*D*–*A*
M1 For starting the algorithm correctly, up to *C*
A1 For the correct cycle *A*–*B*–*C*–*E*–*D*–*A*
Hence required path is *A*–*B*–*C*–*E*–*D*
B1 **3** For a correct path

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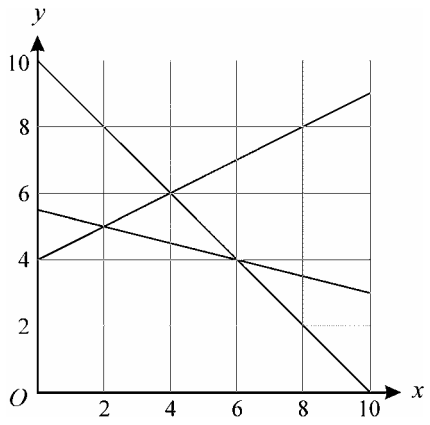
7 **(i)**



	M1	For lines $x+4y=22$ and $x+y=10$
	M1	For line $-x+2y=8$
	A1	For correct diagram including shading
	B1√	For vertices $(0,0), (0,4), (10,0)$
	B1√	For vertex $(2,5)$
	B1√	For vertex $(6,4)$
Hence maximum $P=18$, occurring at $(2,5)$	B1	For the correct value 18
	B1 **8**	For identifying the correct vertex

(ii)

P	x	y	s	t	u	
1	1	–4	0	0	0	0
0	1	4	1	0	0	22
0	–1	2	0	0	1	8

	B1	For the correct pay-off row
	M1	For the use of three slack variables
	A1	For all constraints correct

Pivot on 2 in row 3

1	–1	0	0	0	2	16
0	3	0	1	0	–2	6
0	$1\frac{1}{2}$	0	0	1	$-\frac{1}{2}$	6
0	$-\frac{1}{2}$	1	0	0	$\frac{1}{2}$	4

	M1	For choice of pivot
	M1	For pivoting correctly
	A1√	For correct tableau

Now pivot on 3 in row 1

1	0	0	$\frac{1}{3}$	0	$1\frac{1}{3}$	18
0	1	0	$\frac{1}{3}$	0	$-\frac{2}{3}$	2
0	0	0	$-\frac{1}{2}$	1	$\frac{1}{2}$	3
0	0	1	$\frac{1}{6}$	0	$\frac{1}{6}$	5

	M1	For choice of pivot
	M1	For pivoting correctly
	A1	For correct tableau
Hence $P=18$ when $x=2$, $y=5$	B1√ **10**	For reading off correctly from final tableau

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(iii) Vertices $(0,0) \rightarrow (0,4) \rightarrow (2,5)$ indicated

	M1	For indication of starting at the origin
	A1 **2**	For the correct correspondence indicated
	20	