General Certificate of Education
Advanced Subsidiary Examination
January 2010

Mathematics MD01

Unit Decision 1

Tuesday 19 January 2010 9.00 am to 10.30 am

For this paper you must have:
- an 8-page answer book
- the blue AQA booklet of formulae and statistical tables
- an insert for use in Questions 3 and 7 (enclosed).

You may use a graphics calculator.

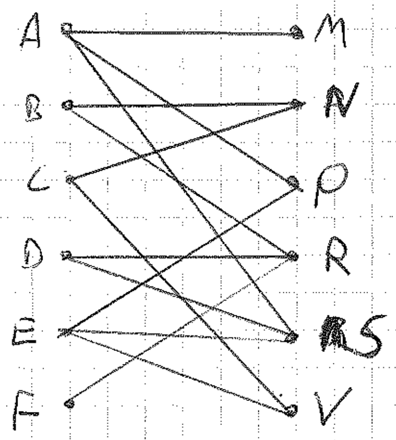
Time allowed
- 1 hour 30 minutes

Instructions
- Use black ink or black ball-point pen. Pencil or coloured pencil should only be used for drawing.
- Write the information required on the front of your answer book. The **Examining Body** for this paper is AQA. The **Paper Reference** is MD01.
- Answer **all** questions.
- Show all necessary working; otherwise marks for method may be lost.
- The **final** answer to questions requiring the use of calculators should be given to three significant figures, unless stated otherwise.
- Fill in the boxes at the top of the insert.

Information
- The marks for questions are shown in brackets.
- The maximum mark for this paper is 75.

1.

(a)



(b) Initial Match

A + P
B + R
C + N
E + S

Alternating path:

D − R + B − N + C − V

D + R   B + N   C + V

New match

A + P
B + N
C + V
D + R
E + S

Alternating path.

had a choice of V or P here

F − R + D − S + E − V + C − N + B − R

~~R D S + E − V + C~~

Not worked!

F − R + D − S + E − P + A − M

F + R   D + S   E + P   A + M

Final (complete) match.

AM
BN
CV
DS
EP
FR

2(a) 1st Pass

$\boxed{13 \quad 16}$ 10 11 4 12 6 7

13 $\boxed{16 \quad 10}$ 11 4 12 6 7

13 10 $\boxed{16 \quad 11}$ 4 12 6 7

13 10 11 $\boxed{16 \quad 4}$ 12 6 7

13 10 11 4 $\boxed{16 \quad 12}$ 6 7

13 10 11 4 12 $\boxed{16 \quad 6}$ 7

13 10 11 4 12 6 $\boxed{16 \quad 7}$

13 10 11 4 12 6 7 16

Note

Full working is shown here - this is not necessary in exam. You must have the last line of each pass shown.

2nd pass

$\boxed{13 \quad 10}$ 11 4 12 6 7 | 16

10 $\boxed{13 \quad 11}$ 4 12 6 7 | 16

10 11 $\boxed{13 \quad 4}$ 12 6 7 | 16

10 11 4 $\boxed{13 \quad 12}$ 6 7 | 16

10 11 4 12 $\boxed{13 \quad 6}$ 7 | 16

10 11 4 12 6 $\boxed{13 \quad 7}$ | 16

10 11 4 12 6 7 13 | 16

3rd Pass.

$\boxed{10 \quad 11}$ 4 12 6 7 | 13 16

10 $\boxed{11 \quad 4}$ 12 6 7 | 13 16

10 4 $\boxed{11 \quad 12}$ 6 7 | 13 16

10 4 11 $\boxed{12 \quad 6}$ 7 | 13 16

10 4 11 6 $\boxed{12 \quad 7}$ | 13 16

10 4 11 6 7 12 | 13 16

4^{th} Pass

$\boxed{10 \quad 4}$ 11 6 7 | 12 13 16

4 $\boxed{10 \quad 11}$ 6 7 | 12 13 16

4 10 $\boxed{11 \quad 6}$ 7 | 12 13 16

4 10 6 $\boxed{11 \quad 7}$ | 12 13 16

4 10 6 7 11 | 12 13 16

5^{th} Pass.

$\boxed{4 \quad 10}$ 6 7 11 | 12 13 16

4 $\boxed{10 \quad 6}$ 7 11 | 12 13 16

4 6 $\boxed{10 \quad 7}$ 11 | 12 13 16

4 6 7 $\boxed{10 \quad 11}$ | 12 13 16

4 6 7 10 11 12 13 16

6^{th} Pass.

$\boxed{4 \quad 6}$ 7 10 | 11 12 13 16

4 $\boxed{6 \quad 7}$ 10 | 11 12 13 16

4 6 $\boxed{7 \quad 10}$ | 11 12 13 16

4 6 7 10 11 12 13 16

No swaps in 6^{th} Pass $\Rightarrow$ can stop.

(b) 1^{st} Pass : Comparisons = 7 Swaps = 6

2^{nd} Pass : Comparisons = 6 Swaps = 6

3^{rd} Pass : ~~Swaps~~ Comparisons = 5 Swaps = 3

3(a) See figure 1 (over page)

$x + 4y = 36$

$(0, 9)$ $(20, 4)$

$4x + y = 68$

$(\cancel{20},$ $(15, 8)$ $(17, 0)$

(b) (i) $P = x + 5y$

OL line:

$m = \dfrac{-1}{5}$

Using OL

Max: $(4, 8)$

$P = 4 + 5(8)$

$= 44$

(ii) $P = 5x + y$

OL line

$m = \dfrac{-5}{1}$

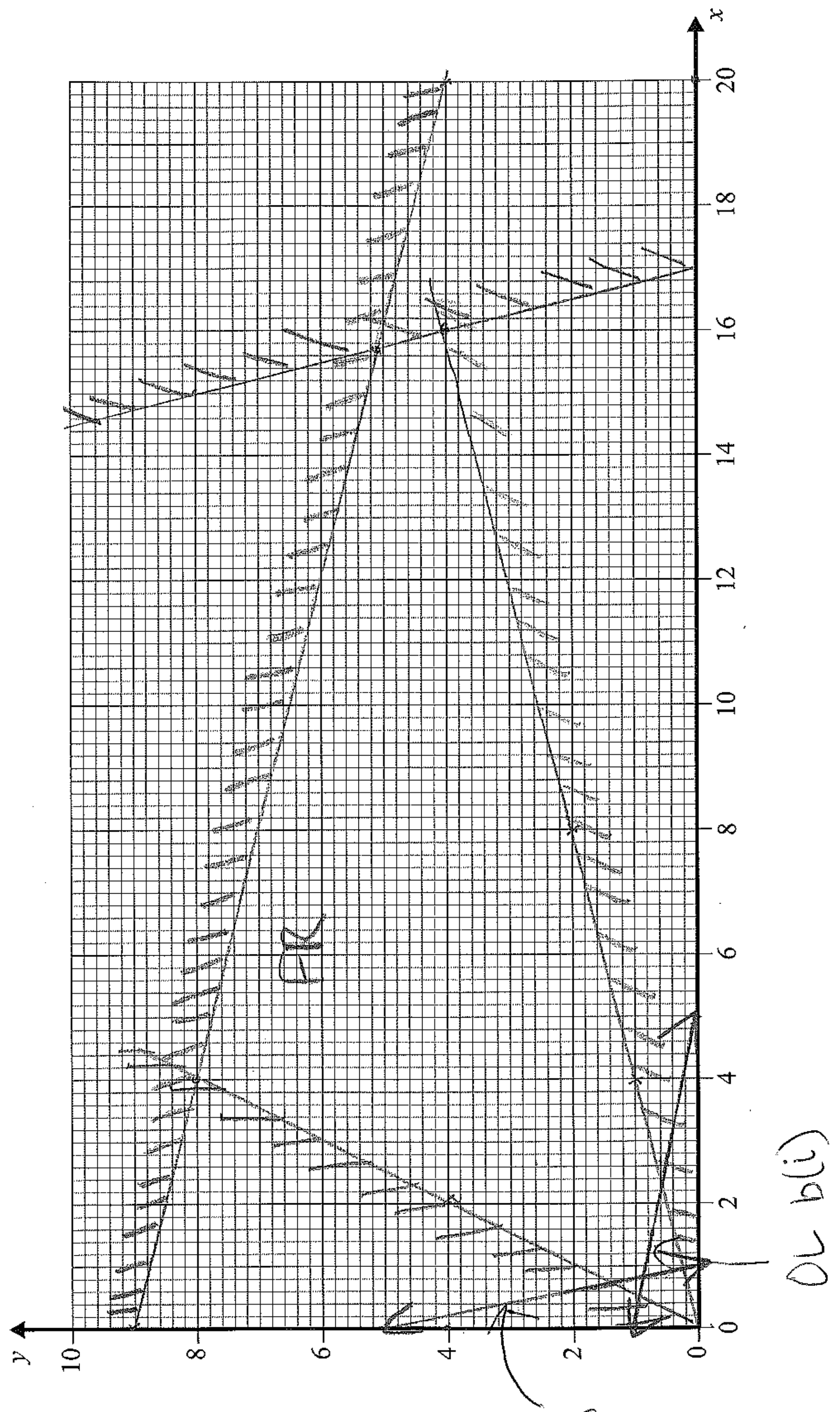
Using OL

Max $(16, 4)$

$P = 5(16) + 4$

$= 84$

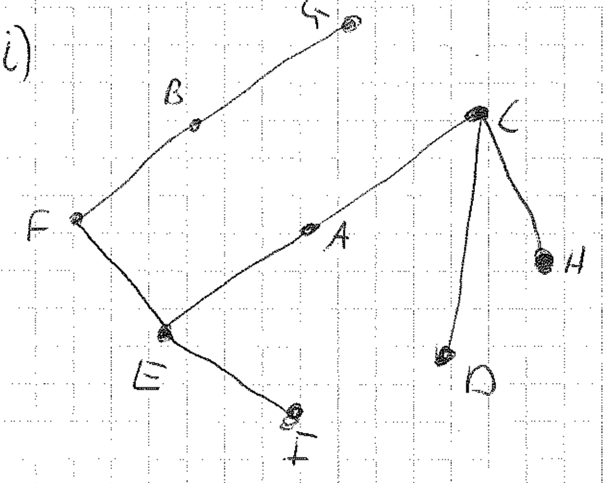
Figure 1 (for use in Question 3)



4(a)(i) AC (13)
AE (14)
EI (15)
CD (16)
CH (20)
EF (21)
BF (19)
BG (19)

(ii) 137

(iii)



(b) Odd vertices
BCDE

BC = 22
BD = 38 (BCD)
BE = 22
CD = 16
CE = 27 (CAE)
DE = 18

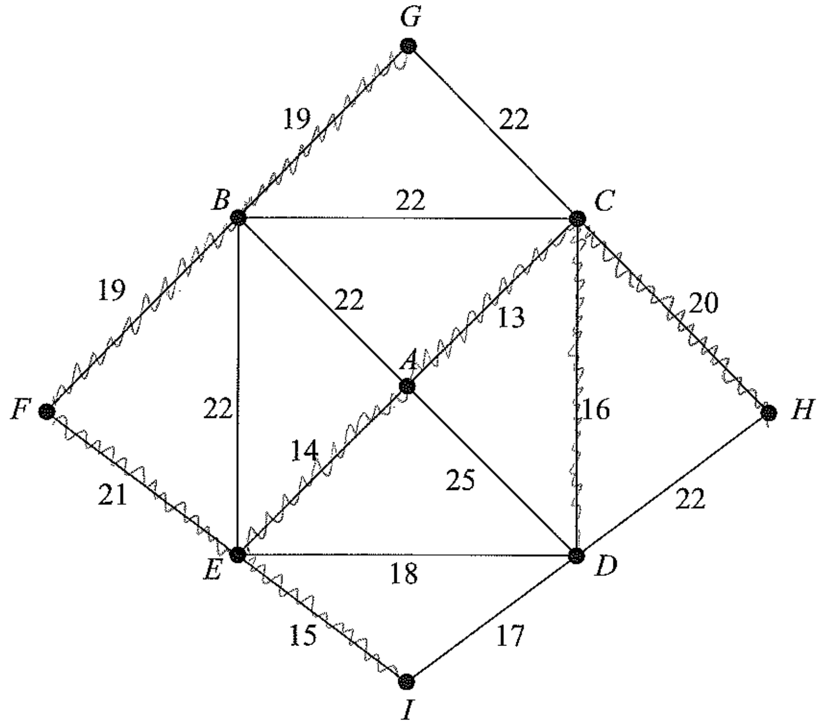
BC + DE = 22 + 18 = 40
BD + CE = 38 + 27 = 65
$\boxed{BE + CD = 22 + 16 = 38}$

Repeat BE and CD.

Min = 307 + 38 = 345.

4 In Paris, there is a park where there are statues of famous people; there are many visitors each day to this park. Lighting is to be installed at nine places, A, B, …, I, in the park. The places have to be connected either directly or indirectly by cabling, to be laid alongside the paths, as shown in the diagram.

The diagram shows the length of each path, in metres, connecting adjacent places.



Total length of paths = 307 metres

(a) (i) Use Prim's algorithm, starting from A, to find the minimum length of cabling required. *(5 marks)*

(ii) State this minimum length. *(1 mark)*

(iii) Draw the minimum spanning tree. *(2 marks)*

(b) A security guard walks along all the paths before returning to his starting place. Find the length of an optimal Chinese postman route for the guard. *(6 marks)*

5(a) $B \to E \to C \to D \to A \to B$

$3.7 + 1.9 + 2.7 + 2.0 + 1.7 \quad = 12$

[redacted] (b) $B \to D \to A \to C \to E \to B$

$1.8 + 2.0 + 1.9 + 4.2 + 3.6 \quad = 13.5$

(c) (a) is a better upper bound (12)

[redacted] (d) Repeat part (b) but now imagine ~~the~~ the words "to" and "from" are swapped over.

You should be crossing out rows here instead of columns.

$B \to A \to D \to E \to C \to B$

$1.7 + 2.0 + 1.7 + 4.2 + 2.5 \quad = 12.1$

5 There is a one-way system in Manchester. Mia is parked at her base, B, in Manchester and intends to visit four other places, A, C, D and E, before returning to her base. The following table shows the distances, in kilometres, for Mia to drive between the five places A, B, C, D and E. Mia wants to keep the total distance that she drives to a minimum.

From \ To	A	B	C	D	E
A	–	1.7	1.9	1.8	2.1
B	3.1	–	2.5	1.8	3.7
C	3.1	2.9	–	2.7	4.2
D	2.0	2.8	2.1	–	2.3
E	2.2	3.6	1.9	1.7	–

(a) Find the length of the tour $BECDAB$. *(1 mark)*

(b) Find the length of the tour obtained by using the nearest neighbour algorithm starting from B. *(4 marks)*

(c) Write down which of your answers to parts (a) and (b) would be the better upper bound for the total distance that Mia drives. *(1 mark)*

(d) On a particular day, the council decides to reverse the one-way system. For this day, find the length of the tour obtained by using the nearest neighbour algorithm starting from B. *(4 marks)*

Turn over for the next question

6(a)

	A	B	N	T	D	H	E
10	1	5	2				
20				0			
30					1		
40						2	
50							1
60				126			
70					3		
90				180			
70					5		

110 : Area = 180 × 1

= 180.

(b)

	A	B	N	T	D	H	E
10	1	5	4				
20				0			
30					1		
40						1	
50							0·5
60				126			
70					2		
90				142			
70					3		
90				196			
70					4		
90				324			
70					5		

Area = T × E

= 324 × 0·5

= 162

7(a) see figure 2 over page.

(b) $38 + x + y = 50 \Rightarrow x + y = 12$ (1)

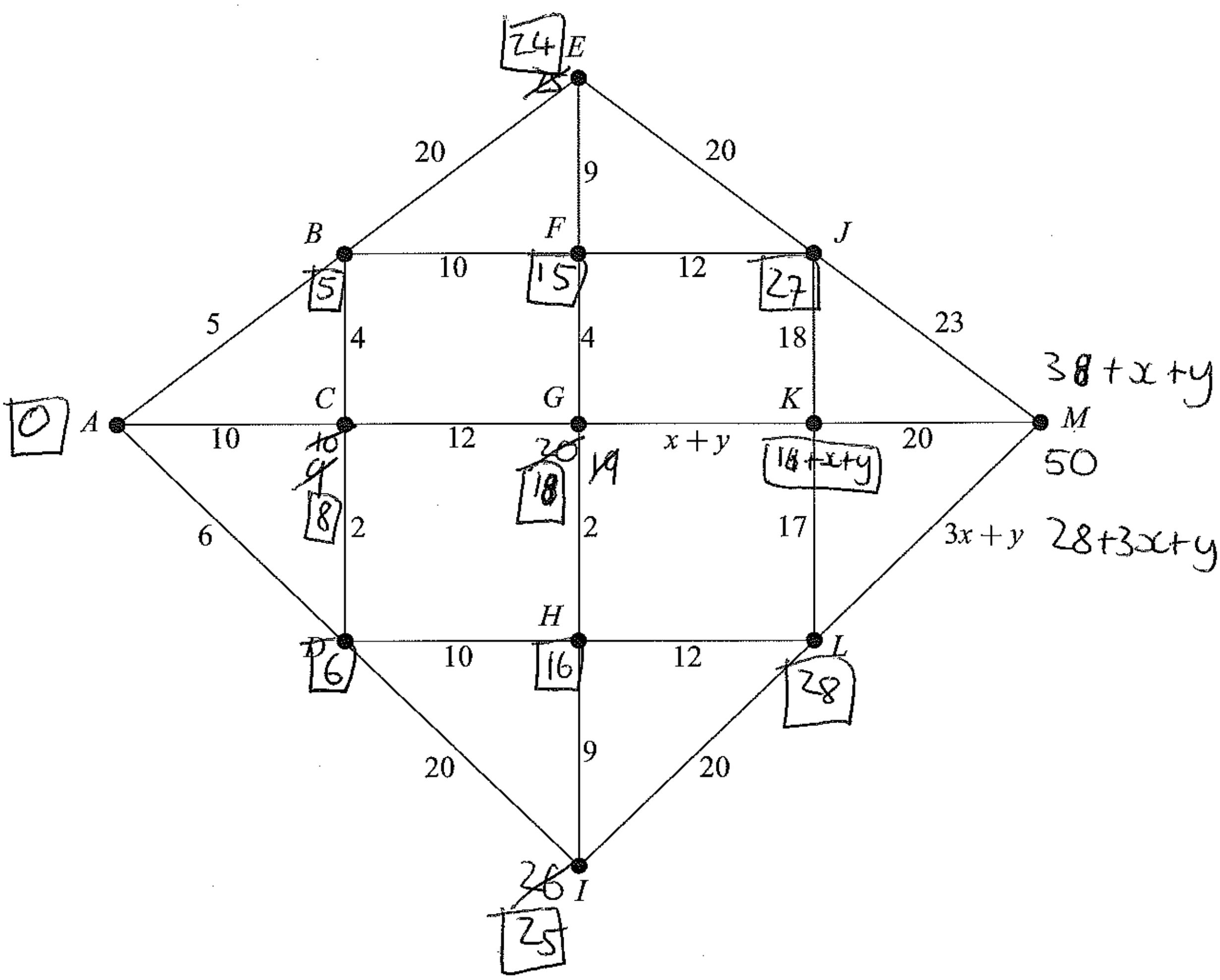
$28 + 3x + y = 50 \Rightarrow 3x + y = 22$ (2)

(2) − (1)

$2x = 10$

$\boxed{x = 5} \Rightarrow \boxed{y = 7}$

Figure 2 (for use in Question 7)



We are told $x + y > 10$

so at K: $18 + x + y > 28$

8. $x = 2A + 3B + 4C$

$y = 3A + B + 3C$

$z = 4A + 5B + 2C$

$$\boxed{\begin{array}{ll} A: & 2x + 3y + 4z \leqslant 360 \\ B: & 3x + y + 5z \leqslant 300 \\ C: & 4x + 3y + 2z \leqslant 400 \end{array}}$$

$A > B$: $2x + 3y + 4z > 3x + y + 5z$

$0 > x - 2y + z \Rightarrow \boxed{2y > x + z}$

$A + B \geqslant C$: $\begin{array}{l} 2x + 3y + 4z \\ + 3x + y + 5z \end{array} \geqslant 4x + 3y + 2z$

$$\boxed{x + y + 7z \geqslant 0}$$

40% total $\leqslant C$:

Total no. of toys: $\begin{array}{l} 2x + 3y + 4z \\ + 3x + y + 5z \\ + 4x + 3y + 2z \end{array} = 9x + 7y + 11z$

$0.4(9x + 7y + 11z) \leqslant 4x + 3y + 2z$

$\frac{2}{5}(9x + 7y + 11z) \leqslant 4x + 3y + 2z$

$2(9x + 7y + 11z) \leqslant 5(4x + 3y + 2z)$

$18x + 14y + 22z \leqslant 20x + 15y + 10z$

$0 \leqslant 2x + y - 12z$

$$\boxed{2x + y \geqslant 12z}$$