

Centre Number						Candidate Number				
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For Examiner's Use	
Examiner's Initials	
Question	Mark
1	
2	
3	
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TOTAL	



General Certificate of Education  
Advanced Subsidiary Examination  
June 2012

# Mathematics

# MD01

## Unit Decision 1

Thursday 24 May 2012 9.00 am to 10.30 am

**For this paper you must have:**

- the blue AQA booklet of formulae and statistical tables.

You may use a graphics calculator.

### Time allowed

- 1 hour 30 minutes

### Instructions

- Use black ink or black ball-point pen. Pencil should only be used for drawing.
- Fill in the boxes at the top of this page.
- Answer **all** questions.
- Write the question part reference (eg (a), (b)(i) etc) in the left-hand margin.
- You must answer each question in the space provided for that question. If you require extra space, use an AQA supplementary answer book; do **not** use the space provided for a different question.
- Do not write outside the box around each page.
- Show all necessary working; otherwise marks for method may be lost.
- Do all rough work in this book. Cross through any work that you do not want to be marked.
- The **final** answer to questions requiring the use of calculators should be given to three significant figures, unless stated otherwise.

### Information

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

### Advice

- You do not necessarily need to use all the space provided.

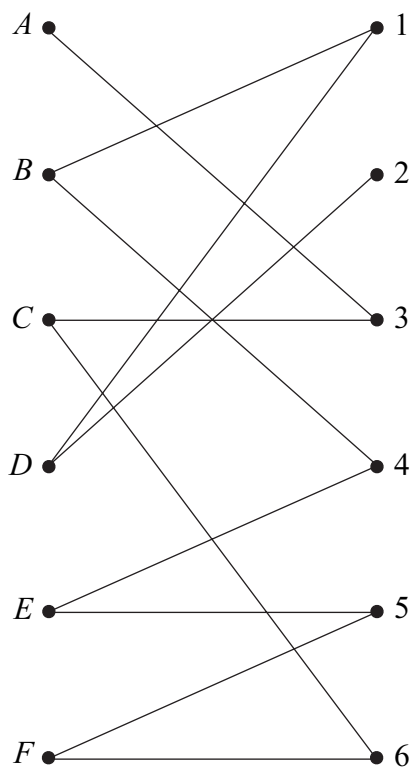


J U N 1 2 M D 0 1 0 1

Answer **all** questions.

Answer each question in the space provided for that question.

- 1** Six people, *A*, *B*, *C*, *D*, *E* and *F*, are to be allocated to six tasks, 1, 2, 3, 4, 5 and 6. The following bipartite graph shows the tasks that each of the people is able to undertake.



- (a)** Represent this information in an adjacency matrix. (2 marks)
- (b)** Initially, *B* is assigned to task 4, *C* to task 3, *D* to task 1, *E* to task 5 and *F* to task 6. By using an algorithm from this initial matching, find a complete matching. (3 marks)

QUESTION PART REFERENCE

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QUESTION  
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**2** A student is using a shuttle sort algorithm to rearrange a set of numbers into ascending order.

Her correct solution for the first three passes is as follows.

Initial list	10	7	4	22	23	26
After 1st pass	7	10	4	22	23	26
After 2nd pass	4	7	10	22	23	26
After 3rd pass	4	7	10	22	23	26

- (a) Write down the number of comparisons on each of the three passes. (2 marks)
- (b) Write down the number of swaps on each of the three passes. (2 marks)
- (c) Explain whether or not the student has completed the algorithm. (1 mark)

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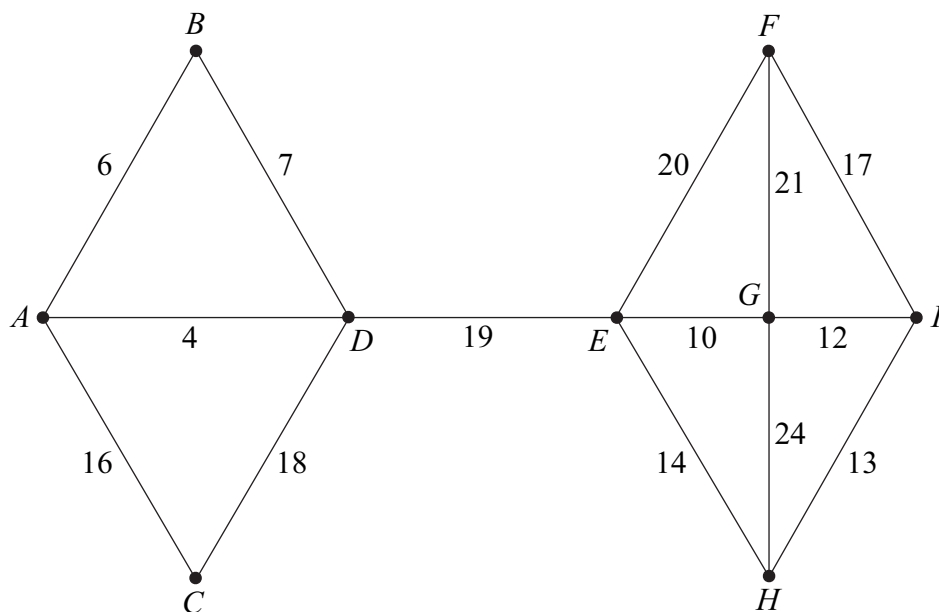
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**3** The following network shows the lengths, in miles, of roads connecting nine villages,  $A, B, \dots, I$ .



- (a) (i) Use Prim's algorithm starting from  $A$ , showing the order in which you select the edges, to find a minimum spanning tree for the network. (4 marks)
- (ii) State the length of your minimum spanning tree. (1 mark)
- (iii) Draw your minimum spanning tree. (2 marks)
- (b) Prim's algorithm from different starting points produces the same minimum spanning tree for this network. State the final edge that would complete the minimum spanning tree using Prim's algorithm:
  - (i) starting from  $D$ ; (1 mark)
  - (ii) starting from  $H$ . (1 mark)

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QUESTION  
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**4** The edges on the network below represent some major roads in a city. The number on each edge is the minimum time taken, in minutes, to drive along that road.

**(a) (i)** Use Dijkstra's algorithm on the network to find the shortest possible driving time from *A* to *J*. (5 marks)

**(ii)** Write down the corresponding route. (1 mark)

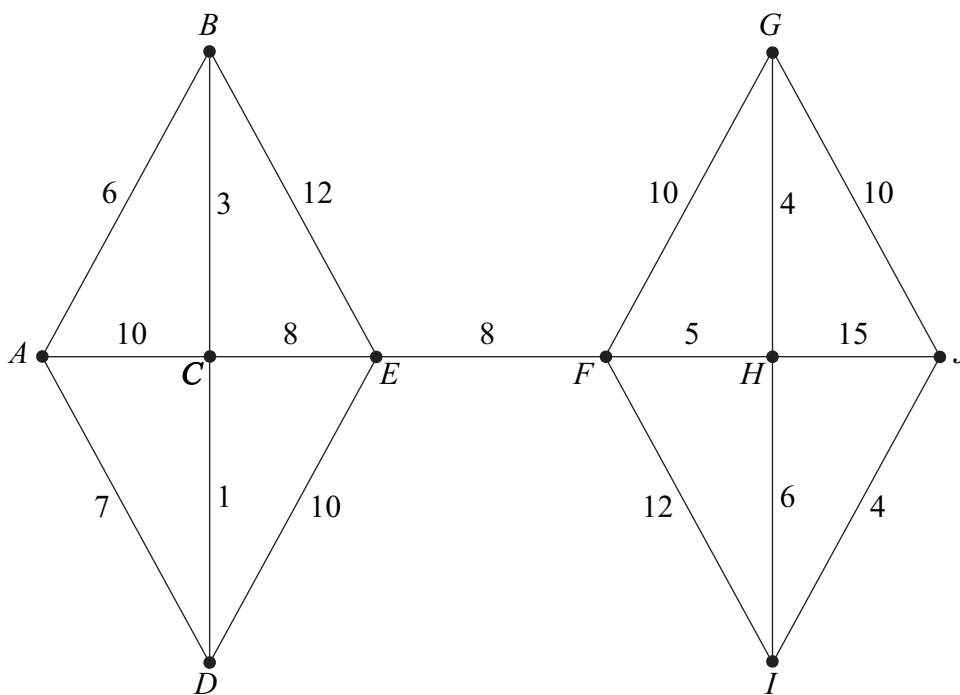
**(b)** A new ring road is to be constructed connecting *A* to *J* directly.

Find the maximum length of this new road from *A* to *J* if the time taken to drive along it, travelling at an average speed of 90 km/h, is to be no more than the time found in part **(a)(i)**. (2 marks)

QUESTION PART REFERENCE

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**(a)(i)**



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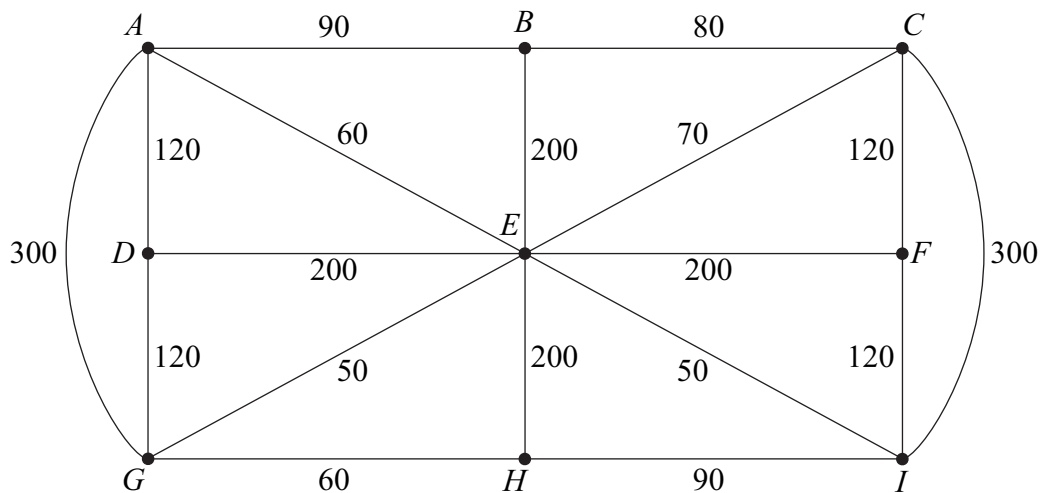
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**5** The network below shows some streets in a town. The number on each edge shows the length of that street, in metres.

Leaflets are to be distributed by a restaurant owner, Tony, from his restaurant located at vertex  $B$ . Tony must start from his restaurant, walk along all the streets at least once, before returning to his restaurant.



The total length of the streets is 2430 metres.

- (a) Find the length of an optimal Chinese postman route for Tony. (5 marks)
  
- (b) Colin also wishes to distribute some leaflets. He starts from his house at  $H$ , walks along all the streets at least once, before finishing at the restaurant at  $B$ .  
  
Colin wishes to walk the minimum distance. Find the length of an optimal route for Colin. (1 mark)
  
- (c) David also walks along all the streets at least once. He can start at any vertex and finish at any vertex. David also wishes to walk the minimum distance.
  - (i) Find the length of an optimal route for David. (1 mark)
  - (ii) State the vertices from which David could start in order to achieve this optimal route. (1 mark)

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- 6** The complete graph  $K_n$  ( $n > 1$ ) has every one of its  $n$  vertices connected to each of the other vertices by a single edge.
- (a)** Draw the complete graph  $K_4$ . (1 mark)
- (b) (i)** Find the total number of edges for the graph  $K_8$ .
- (ii)** Give a reason why  $K_8$  is not Eulerian. (2 marks)
- (c)** For the graph  $K_n$ , state in terms of  $n$ :
- (i)** the total number of edges;
- (ii)** the number of edges in a minimum spanning tree;
- (iii)** the condition for  $K_n$  to be Eulerian;
- (iv)** the condition for the number of edges of a Hamiltonian cycle to be equal to the number of edges of an Eulerian cycle. (4 marks)

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**7** Rupta, a sales representative, has to visit six shops,  $A$ ,  $B$ ,  $C$ ,  $D$ ,  $E$  and  $F$ . Rupta starts at shop  $A$  and travels to each of the other shops once, before returning to shop  $A$ . Rupta wishes to keep her travelling time to a minimum.

The table shows the travelling times, in minutes, between the shops.

	$A$	$B$	$C$	$D$	$E$	$F$
$A$	–	16	10	25	26	40
$B$	16	–	20	19	18	50
$C$	10	20	–	14	22	31
$D$	25	19	14	–	11	32
$E$	26	18	22	11	–	42
$F$	40	50	31	32	42	–

- (a) Find the travelling time of the tour  $ACFDEBA$ . (1 mark)
- (b) Use the nearest neighbour algorithm, starting at  $A$ , to find an upper bound for the travelling time for Rupta’s tour. (4 marks)
- (c) By deleting  $A$ , find a lower bound for the travelling time for Rupta’s tour. (4 marks)
- (d) Sketch a network showing the edges that give you the lower bound in part (c) and comment on its significance. (2 marks)

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**8** The following algorithm finds an estimate of the value of the number represented by the symbol  $e$ :

Line 10      Let  $A = 1, B = 1, C = 1$   
Line 20      Let  $D = A$   
Line 30      Let  $C = C \times B$   
Line 40      Let  $D = D + (1/C)$   
Line 50      If  $B = 4$  then go to Line 80  
Line 60      Let  $B = B + 1$   
Line 70      Go to Line 30  
Line 80      Print 'An estimate of  $e$  is',  $D$   
Line 90      End

**(a)** Trace the algorithm. *(6 marks)*

**(b)** A student miscopied Line 70.

His line was

Line 70      Go to Line 10

Explain what would happen if his algorithm were traced. *(2 marks)*

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**9** Ollyin is buying new pillows for his hotel. He buys three types of pillow: soft, medium and firm.

He must buy at least 100 soft pillows and at least 200 medium pillows.

He must buy at least 400 pillows in total.

Soft pillows cost £4 each. Medium pillows cost £3 each. Firm pillows cost £4 each.

He wishes to spend no more than £1800 on new pillows.

At least 40% of the new pillows must be medium pillows.

Ollyin buys  $x$  soft pillows,  $y$  medium pillows and  $z$  firm pillows.

**(a)** In addition to  $x \geq 0$ ,  $y \geq 0$  and  $z \geq 0$ , find five inequalities in  $x$ ,  $y$  and  $z$  that model the above constraints. (3 marks)

**(b)** Ollyin decides to buy twice as many soft pillows as firm pillows.

**(i)** Show that three of your answers in part **(a)** become

$$3x + 2y \geq 800$$

$$2x + y \leq 600$$

$$y \geq x \tag{3 marks}$$

**(ii)** On the grid opposite, draw a suitable diagram to represent Ollyin's situation, indicating the feasible region. (5 marks)

**(iii)** Use your diagram to find the maximum total number of pillows that Ollyin can buy. (2 marks)

**(iv)** Find the number of each type of pillow that Ollyin can buy that corresponds to your answer to part **(b)(iii)**. (1 mark)

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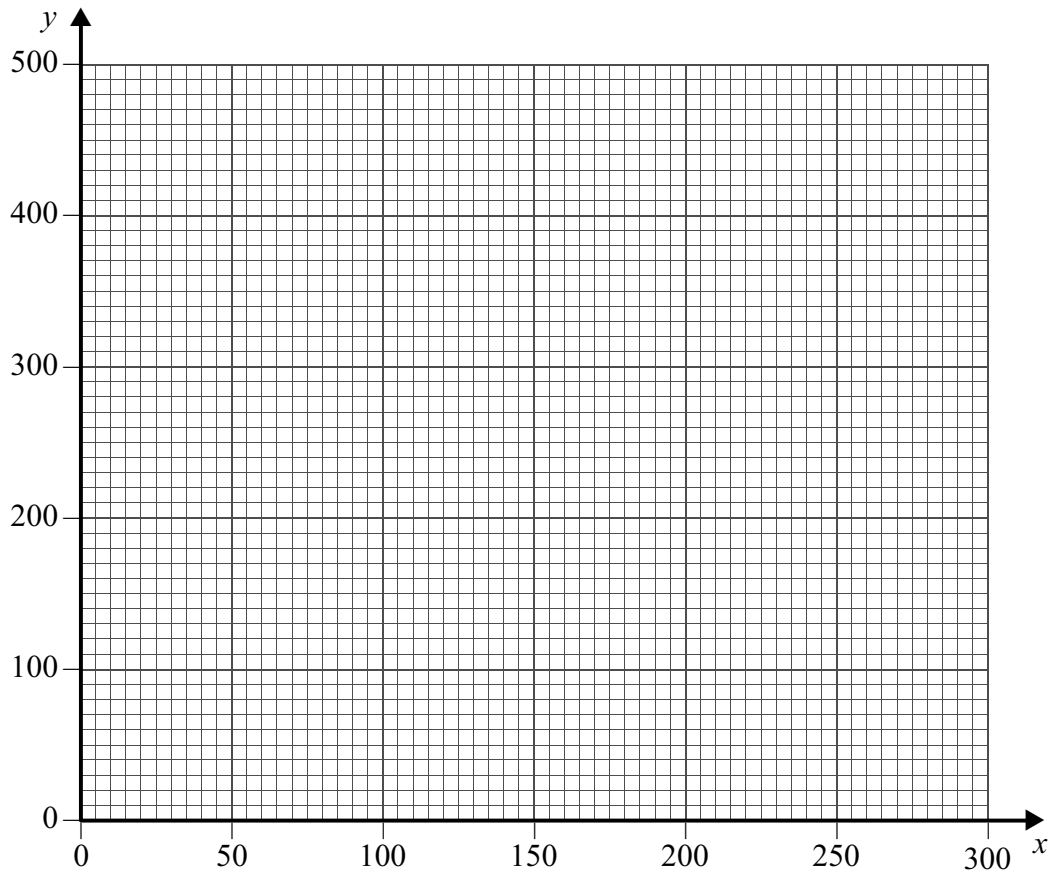
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**END OF QUESTIONS**

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